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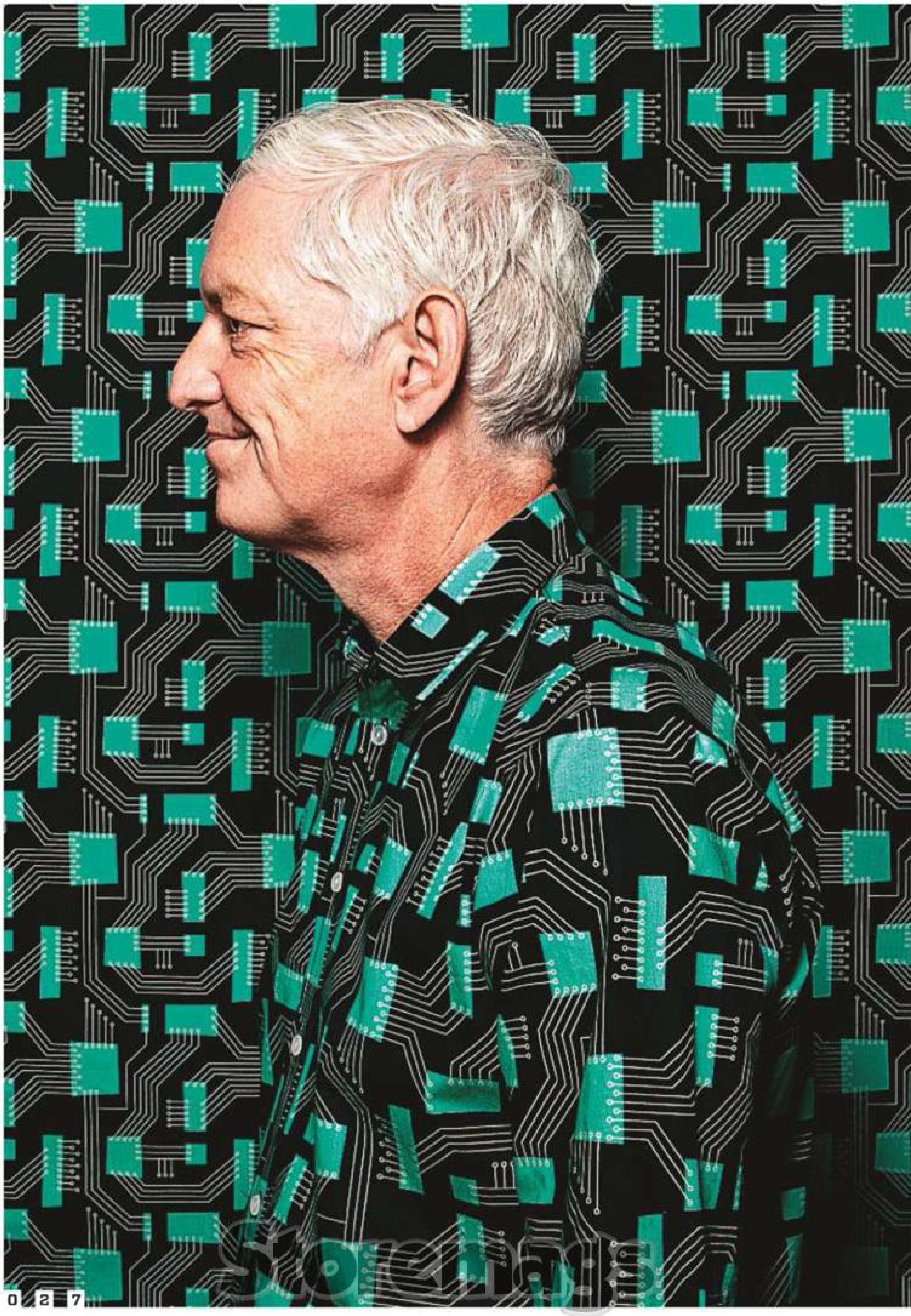

Right: Peter Norvig, director of research at Google

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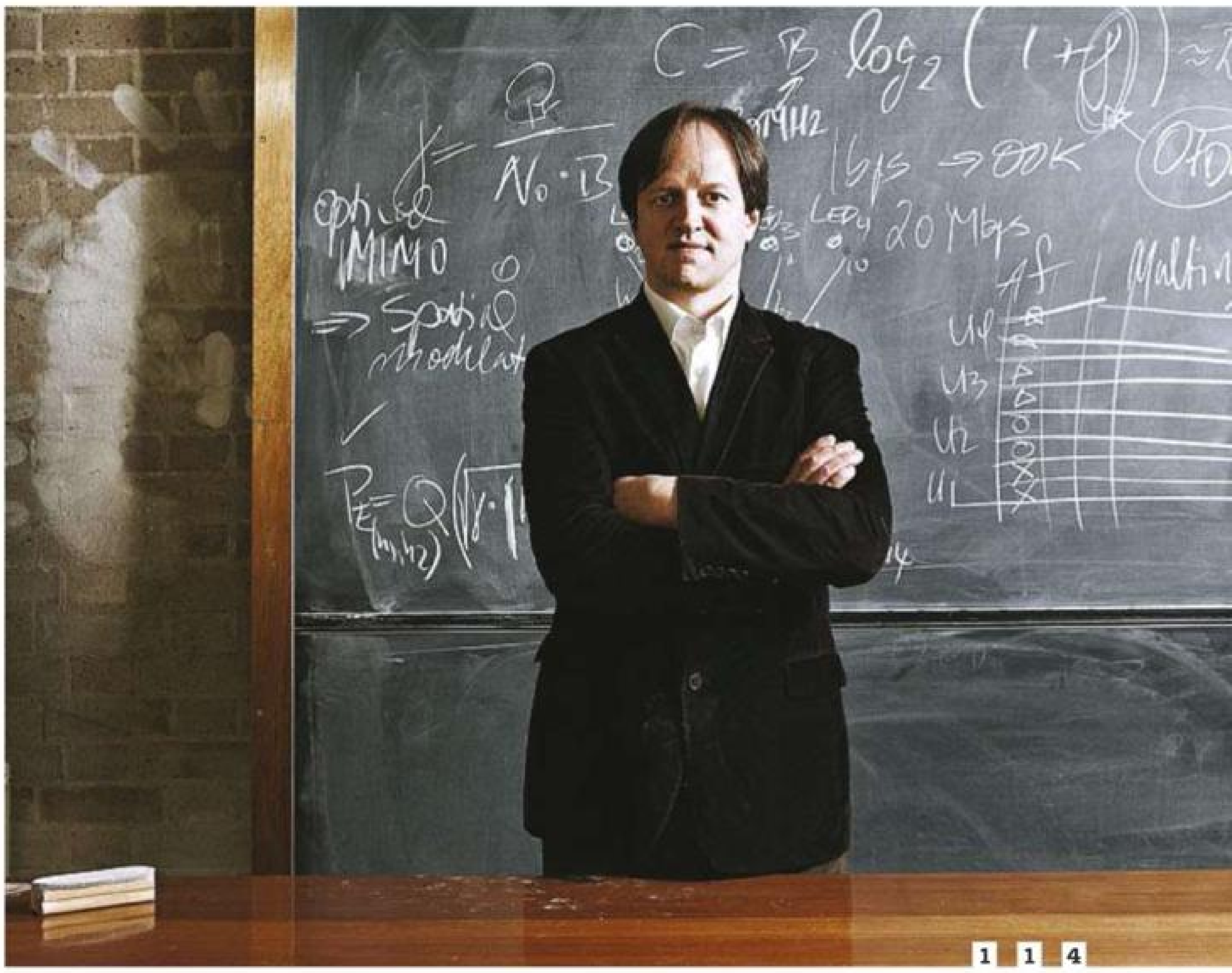

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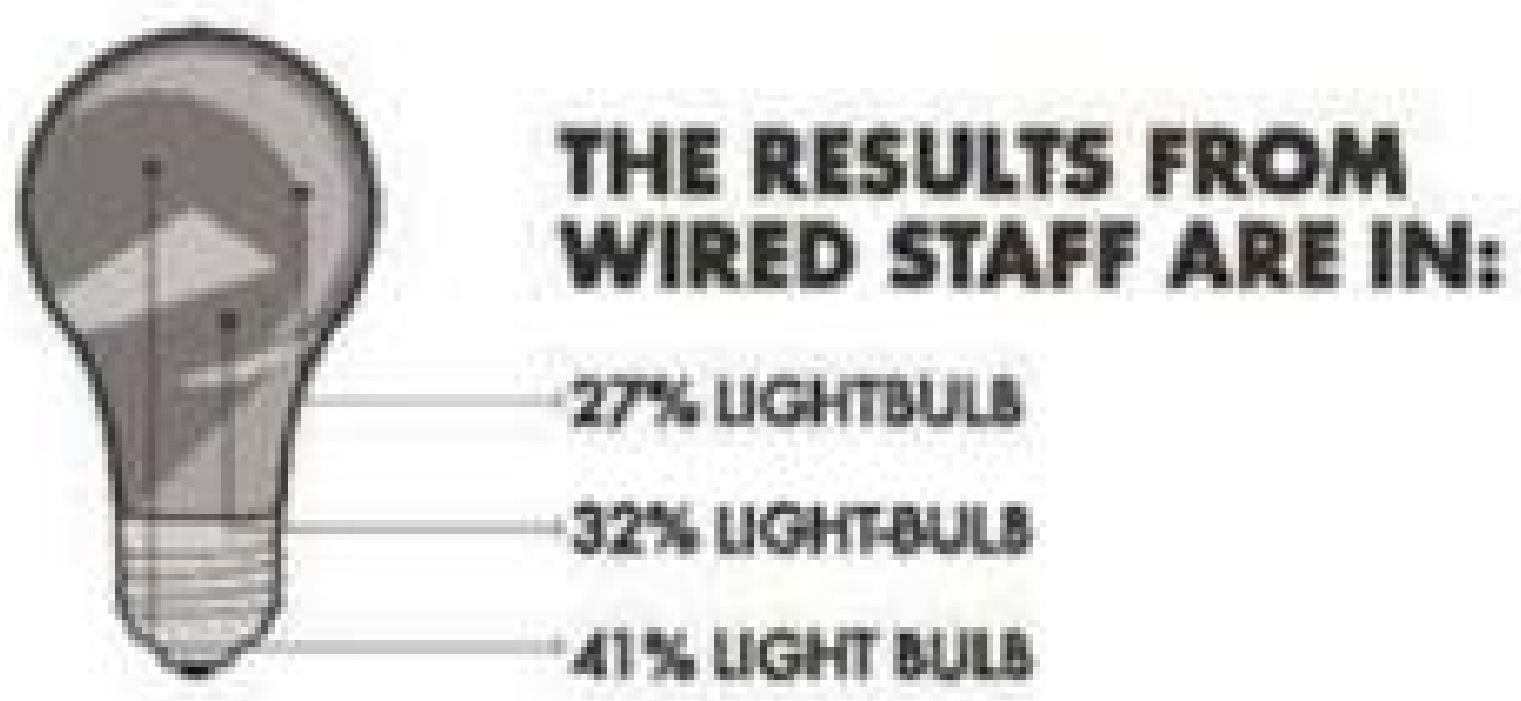
*Excludes 1.4 78 bhp 8v engine.

RANTS

THE BURNING QUESTION

It had us scratching our heads when the Harald Haas feature (p114) was in production. And we're still not too sure. So... how *do* you spell "light bulb"?



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PLUS 24 OTHER MUST-KNOW IDEAS FOR 2012
EXCLUSIVE INTERVIEW AMAZON'S JEFF BEZOS: CEO OF THE INTERNET
VROOM! THE CARS THAT DRIVE THEMSELVES P.124

ZUCK TWEETS

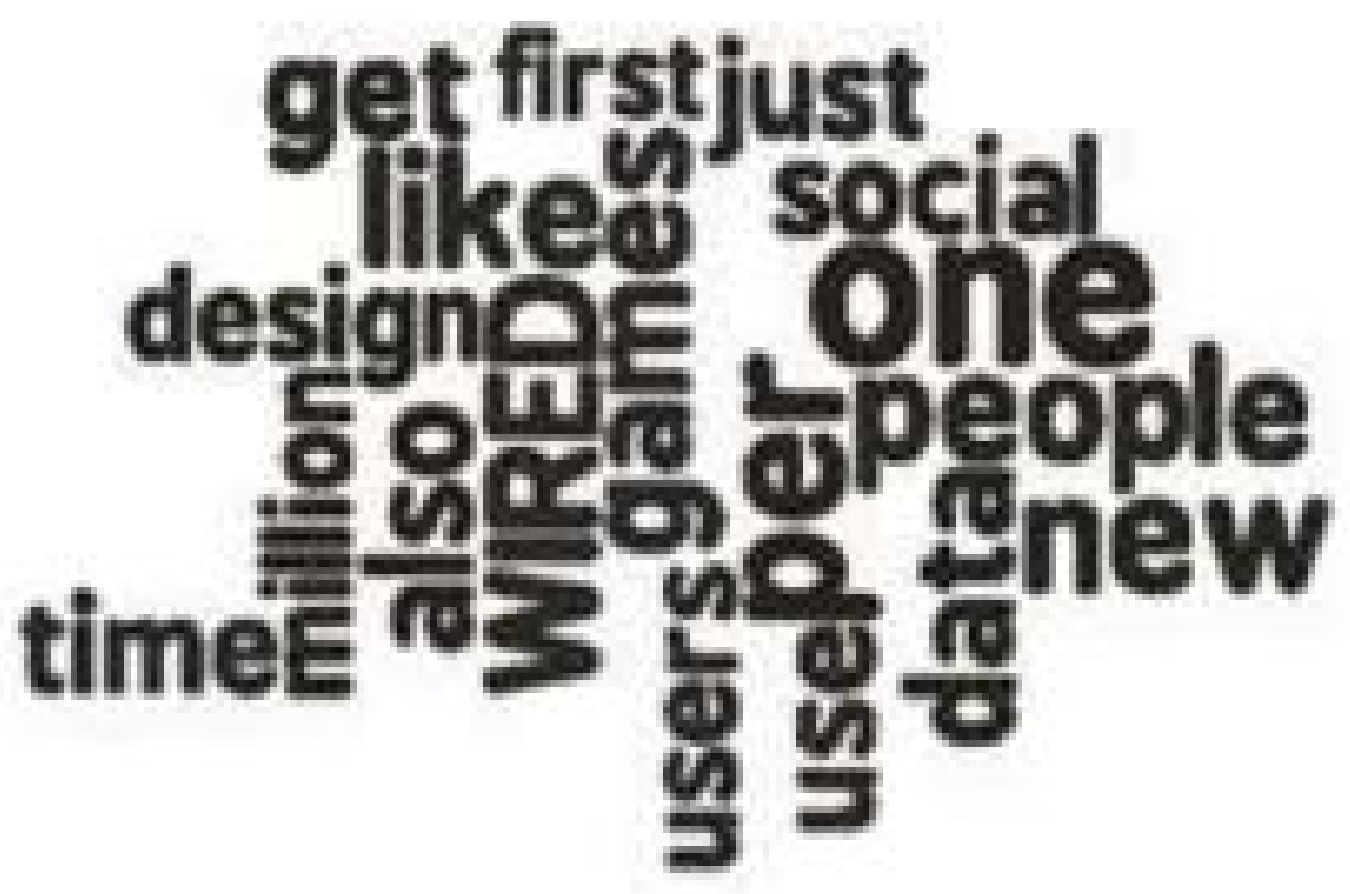
Mark Zuckerberg's face on the new *@WiredUK* cover confirms my suspicion that he is not, in fact, human. Just needs a big F on his forehead. *@NickMitchell*

Zuck on the BBC and now the cover of *@WiredUK*... soft publicity launch to IPO? *@davereinhardt*

The Photoshop guys have done a great job on Zuckerberg on the cover of *@WiredUK*. He should use it as his profile pic. *@sketim*

Does the short Facebook article in Jan 12 issue really merit the massive Zuck head on front cover? *@stunoble*

01.12 Facebook's next big move. Last month we wrote about Mark Zuckerberg's plan to transform every industry around the social graph. It was just one of our 25 Big Ideas for 2012. So, now you're clued-up on neurocinema, the lab on a postage stamp and the sensorimotor cipher, what do you think? And what ideas should we cover in our future issues? Let us know your views.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YOUR ATTENTION, PLEASE

As more forms of media and media devices fight for our attention, it is worrying that we will lose the ability to operate without a mass of visual/audio stimuli bombarding our senses 24/7 (Secondary attention: the new ad frontier, 12.11). In the cinema or any public space people are constantly checking their mobiles, and in the living room co-viewing is becoming more common. I like to watch TV or read, but my wife always reads and "watches" TV at the same time, and my daughter uses her laptop whilst watching the TV. If more devices scramble for our gaze, if not our complete attention, then I think we all will have to learn how to read our sensory environment in a more sophisticated manner. In turn advertisers will have to become equally sophisticated at getting our attention before we learn how to zone them out completely. ***Nigel Watson, via wired.co.uk***

ONE BAD APPLE

I find it offensive that a man as ruthless as Steve Jobs should be depicted in the guise of a Greek Orthodox saint (Steve Jobs, A WIRED life, 12.11). *Anthoulla Koutsoudi, via wired.co.uk*

UNSOCIAL CLUB

How interesting: Yuri Milner as citizen of the world (The connector, 12.11)? But still an outsider anywhere in the world. In Russia people like Yuri Milner are called "unhandshakable". I'm pleased to be an outsider of all their social networks. The article is superb – congratulations to Mr Wolff. *Larissa, via wired.co.uk*

THE 01.12 WORD CLOUD

"WIRED users use data"; "get one first"; "like design"; "social games"; – one thing you can't accuse us of is not knowing our readership.

UNDO 01.12

We forgot to mention last month that the photograph of Lucianne Walkowicz (Planet hunter, 01.12) was taken in the Planetarium at the Royal Observatory, Greenwich.

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Timmo Schreiber

Based in Hamburg, Germany, 37-year-old photographer Schreiber travelled to Dublin to capture Billy Chasen, founder of social-network-cum-nightclub Turntable.fm. And what would be Schreiber's floor-filling track? "It has to be 'Can I Kick It?' by A Tribe Called Quest," he says. "Because it really kicks off." Let's hope he does requests.

Duncan Geere

Wired.co.uk's news editor takes to the printed page this month to explain how to abandon your office chair and work standing up. "We record the WIRED podcast while standing, and it gives it a real energy," he says. "It definitely works – though so far I haven't been able to convince the rest of the office to move to a bank of standing desks and work on laptops."

Andreea Vrabie

A researcher for our Smart List, Vrabie spent two months tracking down global influencers and convincing them to let us know who they currently admire. "I think my favourite pair was James Dyson and [young inventor] Aidan Dwyer," she says. "They exemplify the thinking behind the Smart List: how ideas flow from one generation to the next."

Victoria Ling

Brixton-based Ling photographed the top-three items in Fetish this month. "I wanted to add a little softness to the strong WIRED style. I hope my pictures make you want to touch the items," she explains. "I especially like things that turn a seemingly ordinary function into a pleasure – such as boiled-egg scissors. They're just brilliant."

David Hornik

In this month's Ideas Bank, August Capital's David Hornik posits that, contrary to belief, nice guys don't lose, but they can be under-appreciated. "There will always be successful jerks who perpetuate the stereotype that jerkiness equals success," he says. "'Nice' is about getting the best outcomes – you just do it without stamping your feet or swearing."

Gas?
Where we're going we don't need gas!
DeLorean

Making WIRED

Photographing the DeLorean

Matthew Mahon: It was like travelling back in time when Mahon went to Texas to photograph the electric DeLorean (see p64). "I was 19 when *Back to the Future* came out, so I was struck with nostalgia when I arrived at the factory. It was amazing – nothing but DeLoreans everywhere. It was one of those days where I really enjoyed being a photographer."

Peter Norvig in the studio

Spencer Lowell: "Google research chief Peter Norvig's career is based on the integration of computational technology into humanity," says photographer Lowell. "So I decided to integrate *him* into it. I'd read that he likes loud shirts, so for his portrait [see p27] I had one made using same material as the backdrop. He loved it – he's probably wearing it right now."

PHOTOGRAPHY: TOM NAGY; MATTHEW MAHON; SPENCER LOWELL

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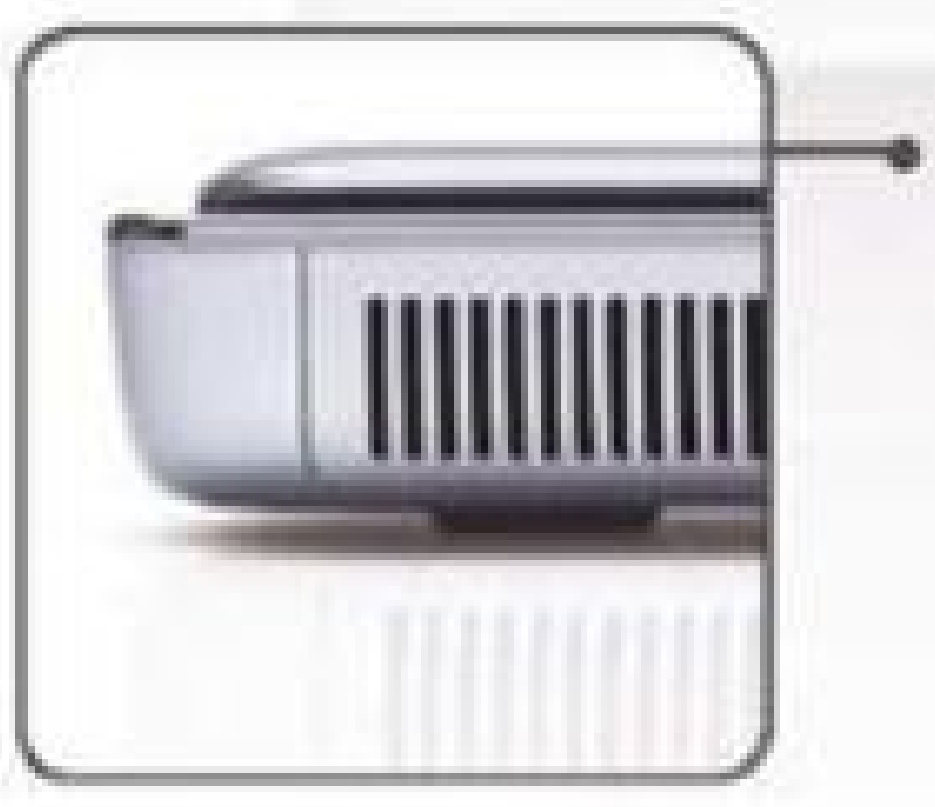
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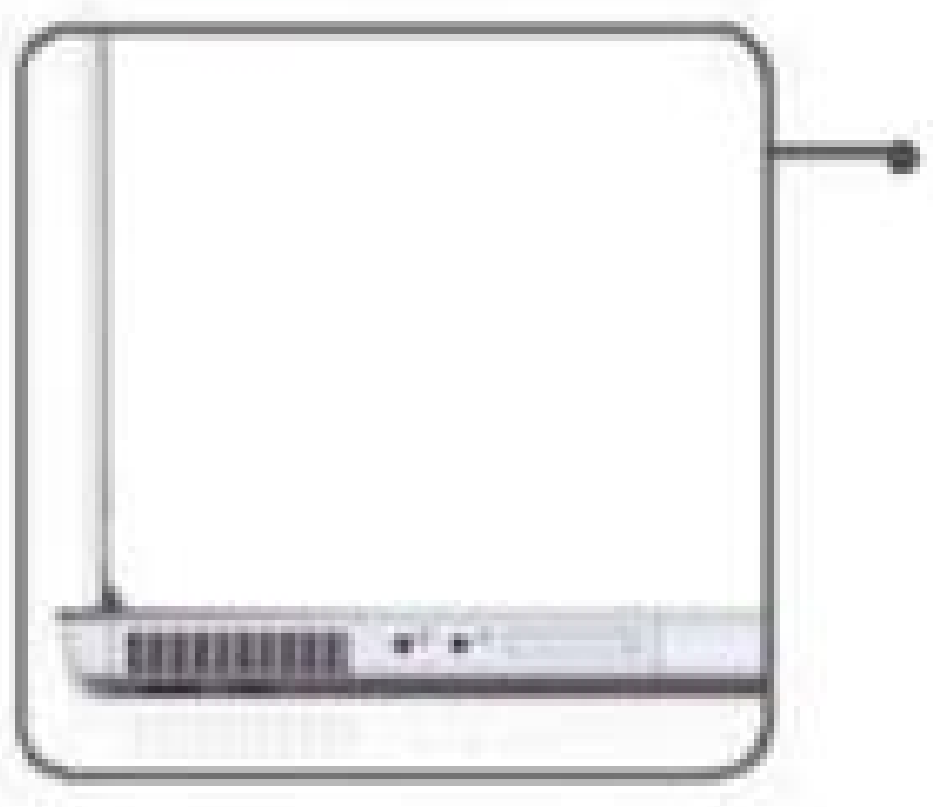
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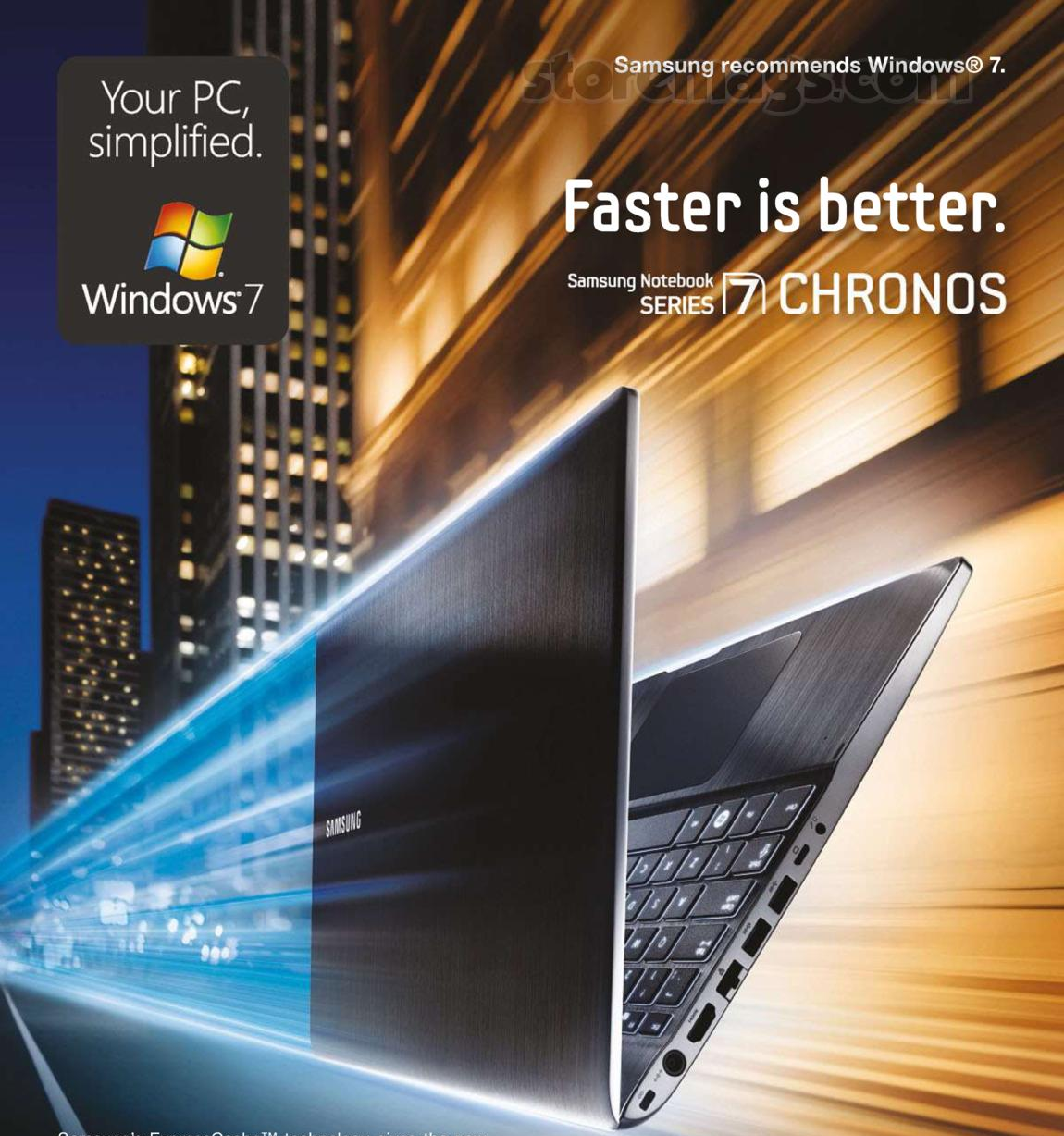

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FROM THE EDITOR

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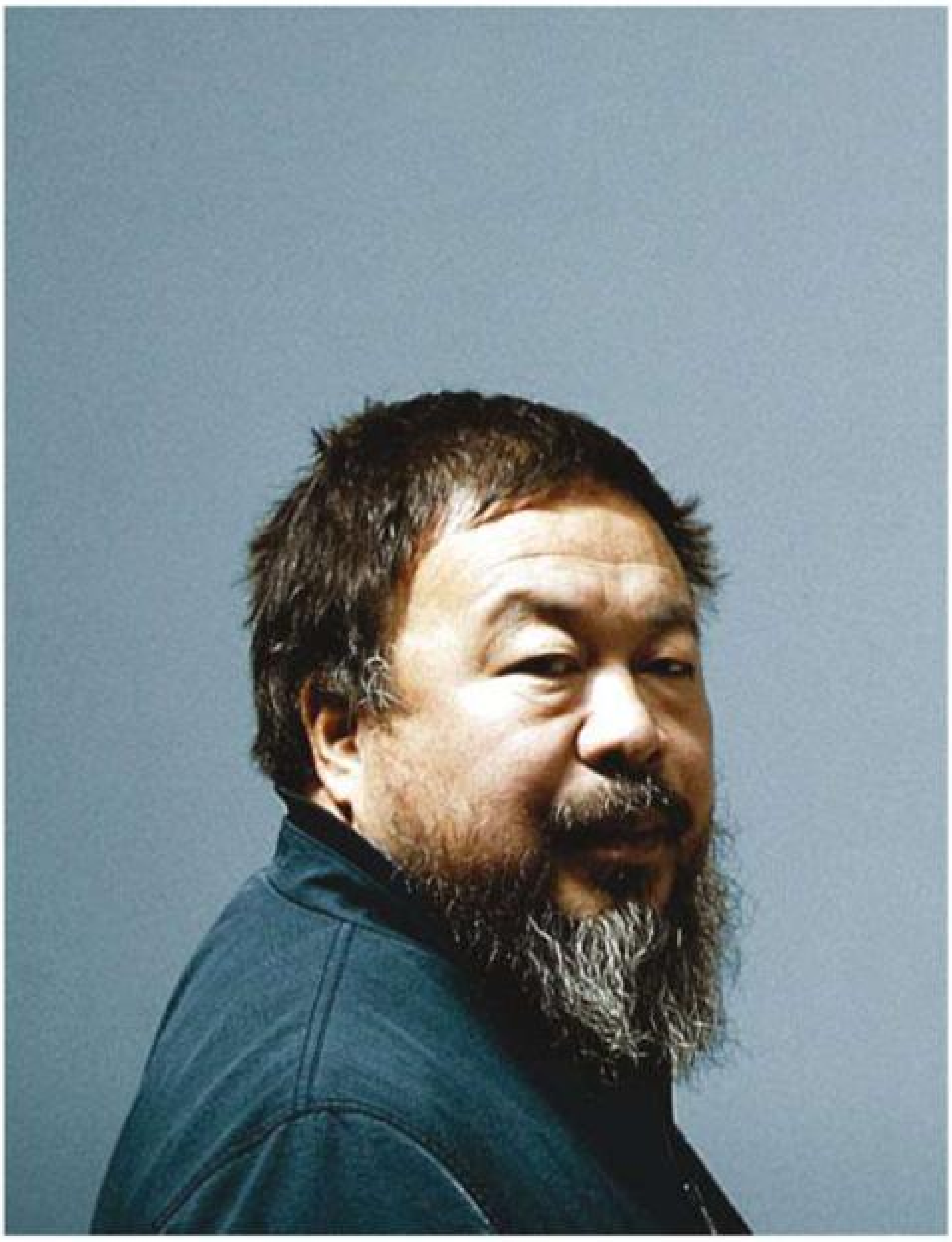
How do you discover tomorrow's world-changers? It's a question we confront every month, as we assess the (literally) thousands of press releases, conference programmes and Twitter and email solicitations that hit our collective in-tray. WIRED, after all, is about guiding you to the people, products and businesses that will matter long after the hype has subsided – even if it's too early to know for sure just what their impact will be.



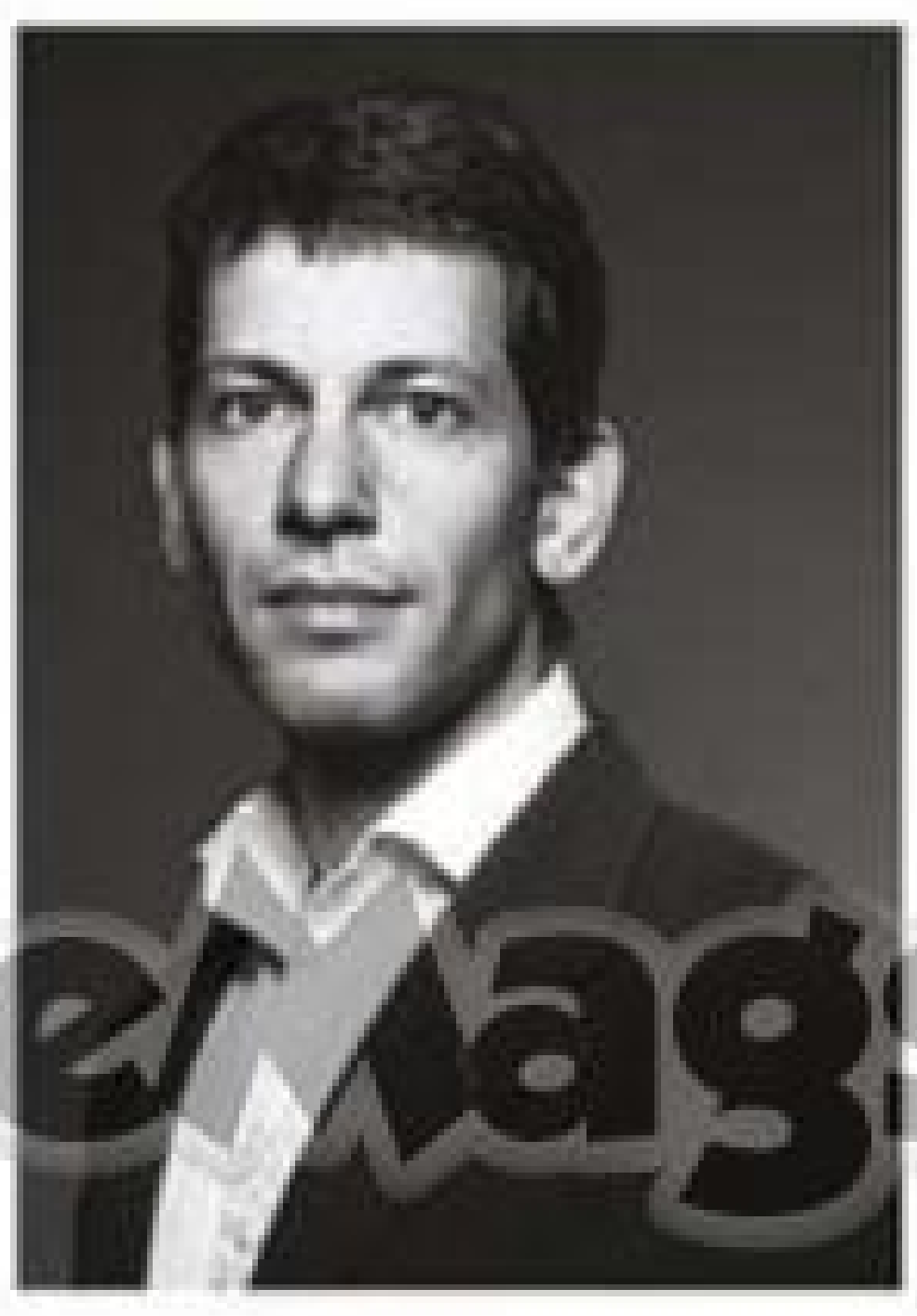
Right: Chinese artist Ai Weiwei nominates future talent

So we came up with a plan. What if we used today's super-achievers as a filter to source tomorrow's? We decided to approach 50 of the people we admire now – from activists to artists, designers to philosophers – and ask them a simple question: if you could have lunch or dinner with an emerging talent in your field, from anywhere in the world today, who would it be? Someone you may never have met, but who, in your view, will be a hugely significant force in the future?

Our cover story this month celebrates their nominations as well as the hope embraced in the creative potential of this new generation. The Smart List, as we're calling it, is a serendipitous delight: as suggestions came in from the likes of Ai Weiwei, Richard Branson and Melinda Gates, we learned of South African fashion designers, Bulgarian human-rights campaigners, New York data scientists who are now on WIRED's radar. We spoke to a Nobel prize-winning economist and life scientists, the founders of Skype and Wikipedia, astronomers and inventors – and discovered talent any of us would want at our dinner tables.

PHOTOGRAPHY: EYEVINE

There aren't many magazines that bring you bionic eyes, WikiHouses, electric DeLoreans and 12-year-old app developers in a single issue. So if you haven't subscribed, give yourself a New Year's boost and do so: wired.co.uk/sub. You'll enjoy our acclaimed iPad edition free of charge when you do so. Smart thinking, right?



David Rowan, Editor

David Rowan

- BSME Art Director of the year, Consumer 2011
- D&AD Award: Entire Magazine 2011
- D&AD Award: Cover 2010
- Maggies Technology Cover 2010
- PPA Designer of the Year, Consumer 2010
- BSME Launch of the Year 2009

START

NEWS AND OBSESSIONS

THIS MONTH:02.12

- MAPPING MICROFINANCE
- THE 12-YEAR-OLD APP DEVELOPER
- NUCLEAR THEME PARK
- EXOSKELETON TECH
- OPEN-SOURCE CONSTRUCTION

EDITED BY **JOÃO MEDEIROS**

Bach and forth

A vast pendulum is the ultimate concert metronome

Artist J Scriba is taking classical music somewhere new – an 84m-tall disused gas-storage tank. His *Bach_10K* installation in Augsburg, Germany, contains an organ that plays a 10,000-second-long performance of Bach's prelude from *The Well-Tempered Clavier,* using a 70m-long Foucault pendulum as a metronome. It cues a computer loaded with a midi track of the music, which then sends signals to 58 organ pipes. "Everybody who enters here seems compelled to make some noise," says Scriba, 47. "So I converted it into a sound space." **Dan Smith** *jscriba.com/bach10k/bach10k.html*

The Foucault pendulum ensures that each note lasts for 17 seconds

WHAT'S INSIDE:
BOMBAY SAPPHIRE GIN

Showered, not stirred

Essence of body wash and a source of cyanide to mix with your Martini

Each month WIRED's chemist Dr John Emsley deconstructs an everyday product. He is the author of 110 research papers and ten books, including his most recent: *Nature's Building Blocks, 2nd edition* (OUP)

INGREDIENTS

Alcohol (40 per cent)
Juniper berries
Angelica
Almonds
Lemon peel
Liquorice
Orris root
Coriander
Cassia bark
Cubeb berries
Grains of paradise

BOMBAY
SAPPHIRE
Distilled
LONDON
DRY GIN
Vapour
INFUSED
Hand-selected
exotic botanicals
FROM A 1761 RECIPE
70cl PRODUCT OF ENGLAND 40%vol

ALCOHOL
Twice distilled and infused with natural flavouring agents, which release traces of volatile chemicals and add flavour and aroma to the gin.

JUNIPER BERRIES
The basis of all gins, they release an oil consisting of cadinene ($C_{15}H_{24}$), camphene ($C_{10}H_{16}$), terpineol ($C_{10}H_{18}O$) and alpha-pinene ($C_{10}H_{16}$).

ANGELICA
This root releases lingustilide ($C_{12}H_{14}O_2$), a ketone with a spicy odour, and beta-terebangelene ($C_{10}H_{16}$), a hydrocarbon with a sweet aroma.

ALMONDS
Heating almonds releases benzaldehyde (C_7H_6O), along with minute traces of the deadly hydrocyanic acid, otherwise known as cyanide (HCN).

LEMON PEEL
Distilling lemon rind releases several aldehydes, dominated by 2,6-dimethyl-5-heptenal ($C_9H_{16}O$). It has a surprisingly melon-like flavour.

LIQUORICE
The root of glycyrrhiza glabra contains glycyrrhizic acid ($C_{42}H_{62}O16$), a complex molecule which is 30 times sweeter than sugar.

ORRIS ROOT
Also known as iris germanica, orris root provides cetonal ($C_{14}H_{24}O$), an aldehyde with woody and raspberry odours. It's used in tinctures.

CORIANDER SEEDS
These add linalool, which has a floral aroma used in shower gel. It was also once used as a pesticide against fleas and cockroaches.

CASSIA BARK
Contains cinnamon, which releases coumarin when distilled. Coumarin can be found in rodenticides and anticoagulants.

CUBEB BERRIES
Provide various oils, of which sabinene and cubebene predominate. They are said to have antioxidant and anti-cancer properties.

GRAINS OF PARADISE
AKA aframomum melegueta, this spice from the ginger family emits 6-paradol, which has a peppery flavour.

PHOTOGRAPHY: SCOTT GRUMMETT

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Behold: it's Kickstarter's bionic woman

After she lost an eye, Tanya Vlach vowed to "become a superhero" – so she crowdfunded an ocular webcam

Vlach's left eye is a 22mm prosthesis into which she hopes to insert a 720p HD camera

PHOTOGRAPHY: DAN WINTERS

Tanya Marie Vlach looks at WIRED across the table. "My dream," she says, "is to become a cyborg, an enhanced human being." In the summer of 2005, the artist, ballerina and producer, now 38, was driving her Jeep towards Burning Man in the Nevada Desert when the brakes failed, she lost control of the vehicle and crashed.

Six days later she woke up in hospital. She could move her legs, but had lost the vision in both eyes. The doctors told her that the right eye would recover but her left eye was gone forever. "I hate feeling like a victim, impotent, weak," she says. She started a blog, One-Eyed (now renamed Eye, Tanya), which explored technical ways she might regain her sight. By 2008 she was investigating the possibility of installing a camera inside her prosthesis. A bionic eye.

"I want to become a superhero," she said at the time. "I want to zoom in on people without them knowing. I want to take pictures of the best moments of my life. I don't want to be disabled. I don't want to be monocular. I don't want to feel like a loser."

She contacted US WIRED founding editor Kevin Kelly with details of her proposal to develop an ocular webcam or "eyecam". Kelly posted details about the project on his Lifestream blog, and she was soon receiving messages from enthusiasts, engineers and scientists around the world. She wasn't the first to attempt this. Rob Spence, a Canadian film director, lost the sight in his right eye at 13 and inserted a webcam into his eye socket "to film everything I want". But Vlach's intentions were different.

"I know Rob, he's like a twin," she says. "But I have different aims. I have no interest in recording everything that I see. That's very 90s – ubiquitous computing, lifelogging and the like. What I am interested in is demonstrating that today, thanks to accessible technology, anyone can become enhanced. We can transform ourselves and repair damage almost immediately."

From a technological perspective, Vlach had (and still has) two options: fit a wireless webcam into her eye, or wait for a new generation of cameras that could be connected directly to the brain. She chose the former and, last June, launched an appeal on the Kickstarter crowdfunding site to raise $15,000 (£9,300) to develop an eyecam that could be installed inside her prosthesis. By the beginning of August, thanks to ⟶

donations from more than 300 people, she had raised almost $20,000 for her project.

Now all she needs to do is crowdsource the technology (*see below*).

In the meantime, Vlach has reinvented herself as a champion of bionics. She is documenting her experience through a multimedia project entitled *Manual of a Man from the Future*.

"On the one hand [the project] describes the development of my bionic eye," she says, "and on the other celebrates the idea of body-tech, the enhancement of the human race through technology. I want to tell this story though web media, from Facebook to Twitter, and on my blog. I want to write a series of articles about the future of cybernetics, of genetic engineering, and cyberidentity, of sousveillance, of transhumanism and of singularity through interviews with experts from all fields. But I also want to shoot shorts and brief documentaries, draw cartoons and develop videogames."

Her blog leads with her original, November 2008, "Call for engineers", which sets out the technical challenge for enhancing her prosthetic (though there is also a very recent [25.10.11] entry on "What does a bionic hair style look like?"). As WIRED went to press, the post had gathered a healthy 231 comments, many from engineers offering practical and technical suggestions. As to when Vlach will start to put any of these into practice, it's a case, for now, of watch this space. **Matteo Bittanti**
tanyavlach.wordpress.com

LOOKING FORWARD: THE TECH VLACH WANTS TO SEE IN HER EYECAM

Vlach already has a prosthetic eye, made of coloured Perspex, roughly 22mm in diameter and 8mm thick. Into this she is hoping to install a 720p HD camera, which would transmit images to a mobile device using Wi-Fi or Bluetooth. (She also lists Firewire/USB/Mini HDMI on her wishlist, though it's hard to see how these might be useful.) The camera would have a 3x optical/digital zoom and be powered by a rechargeable battery, also inside the prosthesis.

The camera's signals would be processed by a custom app that would run on a standard smartphone. The phone's screen would display what the eye was "seeing" and controls could trigger video-capture, zoom etc.

Perhaps more challengingly, Vlach would also like the camera to behave in an "eye-like" way – responding to blinks, for example, and dilating its pupil in low light. She is also investigating how she could see in infrared and ultraviolet, and incorporate face-recognition capabilities. Finally, the whole device has to be waterproof.

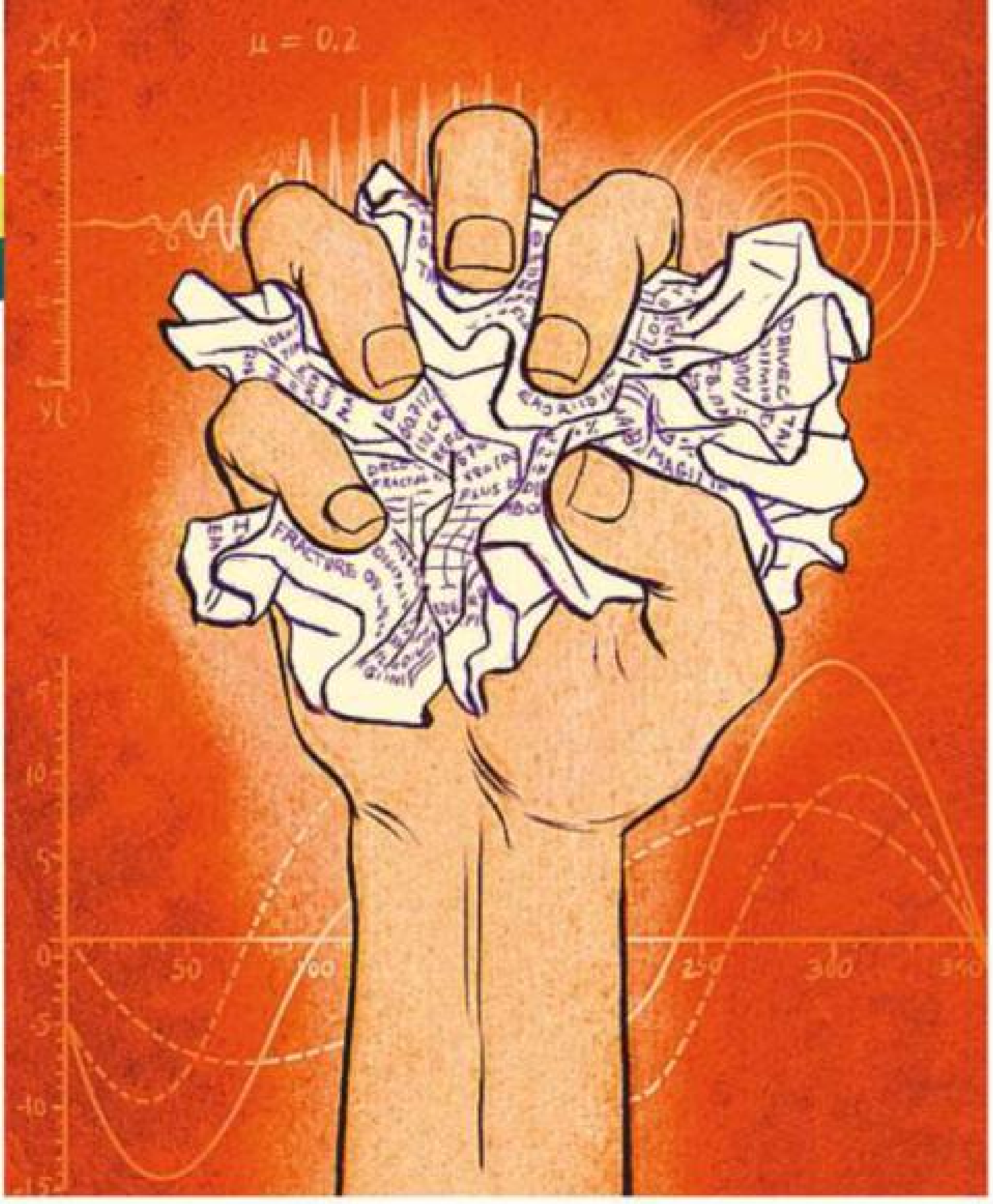

ILLUSTRATION: PABLO BISOGLIO

[This article is retracted]

Try not to panic, but science can sometimes go wide of the target: in 2011, there were 38 retractions for every 100,000 papers published. Retraction Watch, a blog founded by Ivan Oransky, executive editor of Reuters Health, and Adam Marcus, managing editor of *Anesthiology News*, highlights such errors. "The more retractions we cover, the more we see how little standardisation there is in how journals deal with them," says Oransky. "This chaos isn't particularly helpful to journal readers – that is, scientists. So we hope to provide some sunlight." Oransky says that retractions are "born of many mothers". Here are his four favourite offspring. **TC** *retractionwatch.wordpress.com*

1. ANIL POTTI

When *The Cancer Letter*, a publication for oncologists, reported that Anil Potti had faked his credentials as a Rhodes scholar, his studies were suspended. Subsequent investigation found flaws in other studies, leading to the retraction of seven papers at the time of going to press, including one which has already been cited 27 times since 2008.

2. JATINDER AHLUWALIA

After UCL researchers retracted a paper on innate immunity, one of them, Jatinder Ahluwalia, refused to sign. Anthony Segal, a team member who led the research, alleged that Ahluwalia doctored his results and sabotaged his colleagues' work. In November 2010, UCL found him guilty of scientific misconduct. His appeal to UCL was unsuccessful.

3. NAME WITHHELD

In November 2010, Wnt Research, a Swedish biotech firm, postponed its IPO when the paper that formed the basis of some of its work on breast cancer treatments had to be retracted. The scientist responsible for the error gave back the shares awarded him at the company's founding – leaving him $244,000 (£150,000) out of pocket.

4. UNNAMED RESEARCHER

The authors of a *Journal of Immunology* study retracted it after they realised they had used the wrong mice – but by then the study had been cited 11 times. Cliff Snapper, the paper's senior author, contacted Retraction Watch to explain: a researcher had used a photocopy of the same mistaken invoice each time she put in an order for new mice.

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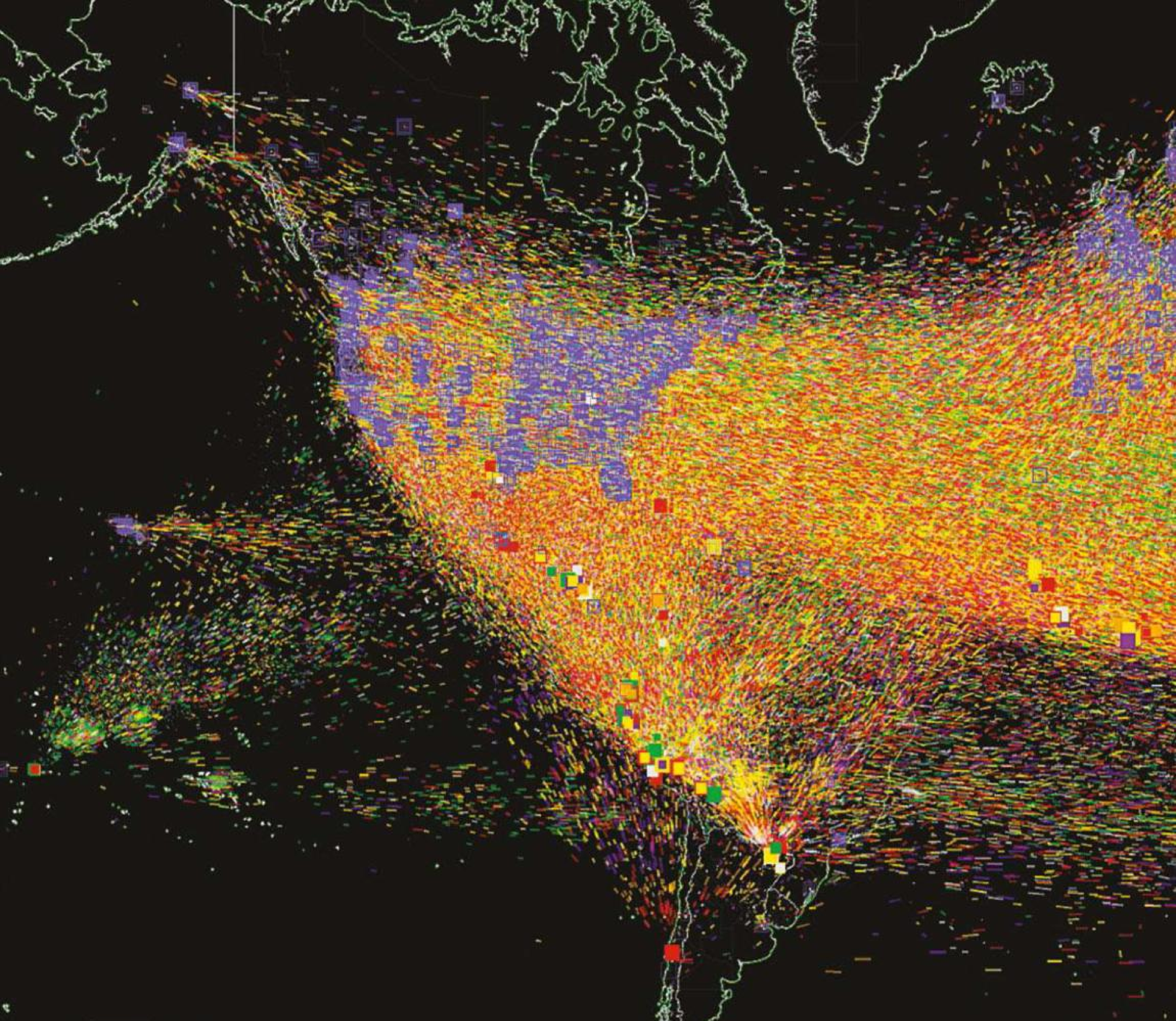


INFO
PORN

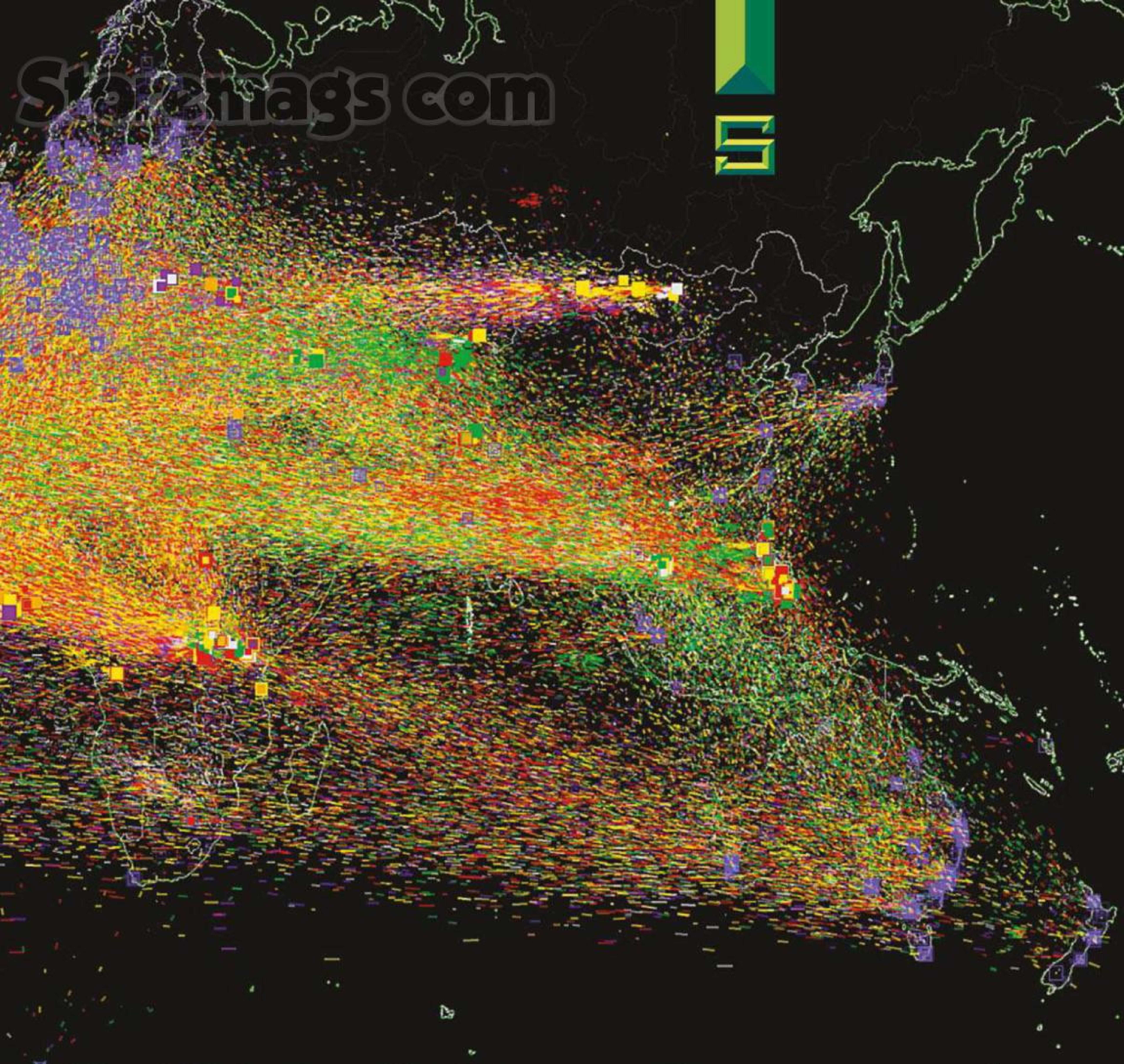
Kiva's microloan map of the world

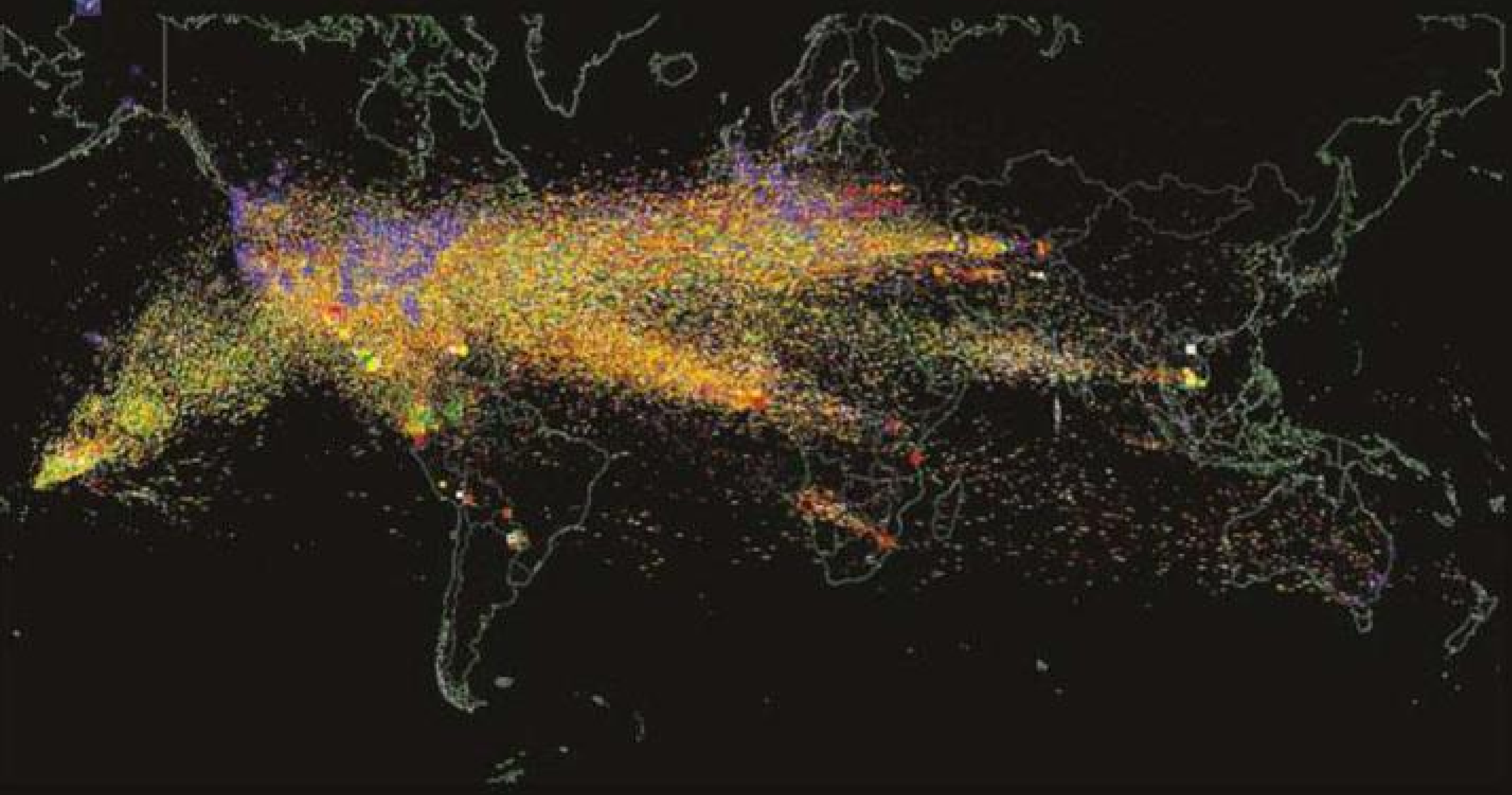
Where those needing funds can find them from willing lenders

Every dot on this image is a loan on a virtual journey, either travelling to a borrower or returning to a lender. The cash flow was mapped by Andy Kalinowitsch and Zvi Boshernitzan, engineers at Kiva, a San Franciscan enabler of microloans (WIRED, 6.10). Kiva connects those in need of funds – without access to conventional banking – to people willing to lend. On July 25, 2011 (*main picture*), £131,000 was lent around the world. All told, £160 million has been lent through Kiva, with a default rate of just 1.07 per cent. "We have a lot of data on our community," says Kalinowitsch. "But when we look at it as numbers, it's difficult to appreciate what it represents. After the first render, we thought, 'Wow, this is really going to allow us to see the fruits of our labour.'"

In 2011, Kiva's most successful year so far, £45 million was lent around the world, compared with a mere £64,592 in 2005. **Dan Smith** *kiva.org*

iPad extra!
Download the WIRED app to see the full Kiva loan animation





Above: on July 25, 2011 £131,000 was loaned
Left: on July 25, 2007 the figure was £25,000

INDUSTRIES THAT RECEIVED LOANS

- 🟩 Agriculture
- 🟨 Food
- 🟥 Retail
- 🟧 Service
- ⬜ Health
- 🟪 Clothing
- ▨ Education

KIVA LENDING PER YEAR

2005	£64,592
2006	£1,218,723
2007	£10,268,957
2008	£22,722,080
2009	£36,232,321
2010	£44,823,047
2011	£45,520,528
TOTAL	£160,785,658

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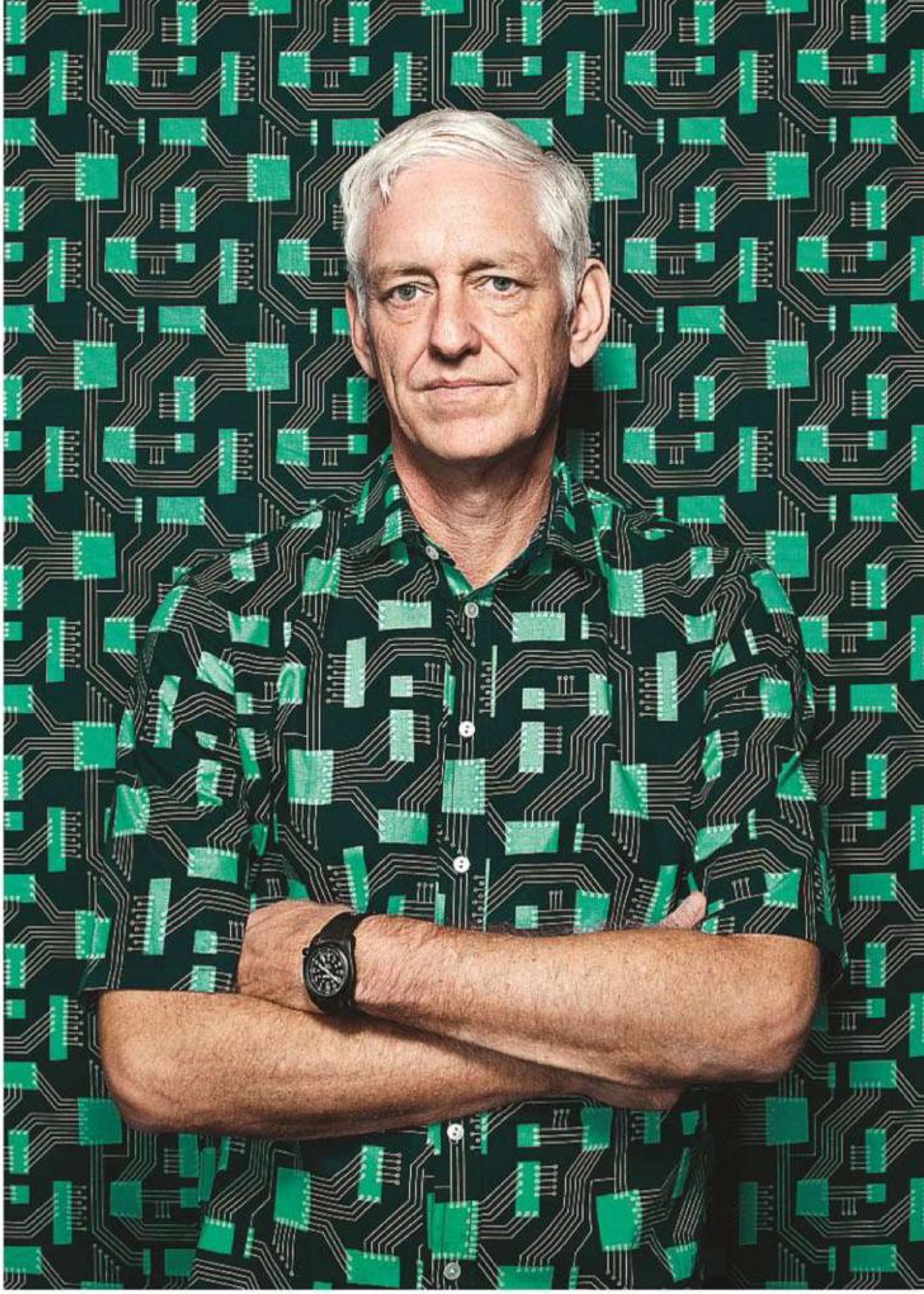
Google's go-to AI guy

Research chief Peter Norvig sees phones getting much smarter



If you're living in fear of the robot uprising, Peter Norvig, Google's director of research, has some bad news: artificial intelligence (AI) is already here. On the plus side, Norvig, who teaches AI at Stanford University and is the coauthor of *Artificial Intelligence: A Modern Approach*, argues that robots are helping us, rather than trying to destroy us. WIRED sent a human to question him.

How do you introduce AI to your students? We think of AI as understanding the world and deciding how to make good decisions. Dealing with uncertainty but still being able to make good decisions is what separates AI from the rest of computer science.

So AI isn't all about talking robots? We try to get away from that part and leave it to philosophers. We tell our students that there are multiple ways of thinking of AI. Do you want to focus on thinking or doing? We want to focus on the actions, because that's what matters. Computer scientist Edgar Dykstra said that the question of whether computers can think is like the question of whether submarines can swim. In English, we say submarines don't swim, but we say aeroplanes do fly. In Russian, they say submarines do swim.

If we don't think of AI as HAL, is it already here? Behind the scenes, machines are doing so much. Every time you buy something with a credit card, there are AI programs trying to detect whether this is fraud or not. And that just goes on. It's everywhere. In the last 20 years the idea of what AI is seems to have changed. Now it's much more embedded and is everywhere. In the movie *2001*, the idea was that AI was one big machine. Now, we think of it more as something that you hold in your hand than something that fills a room. It's embedded everywhere, and it's there not to reason and do everything by itself, but rather to help you do what you want to do.

If that's the case, how useful is the Turing test? I don't like it that much, in part because I don't care about the philosophy angle. I want to build something useful. We already know how to make humans; I made two of them.

So what's next? A lot of it is around mobile technology. You've got microphones and cameras out there, so we're interacting with the world in terms of these rich types of data. That data is harder to understand, it's analogue rather than digital.

You'll see better integration in terms of things always being with you: maybe you'll be wearing a Bluetooth headpiece, or you'll have a display in your glasses, and there will be reminders all the time, like, "Hey, this person walking up to you, this is their name, you met him three years ago and this is what you talked about." And you can look like you know what you're saying. **TC** *norvig.com*

Peter Norvig: "AI is not here to do everything by itself, but to help you"

PHOTOGRAPHY: SPENCER LOWELL

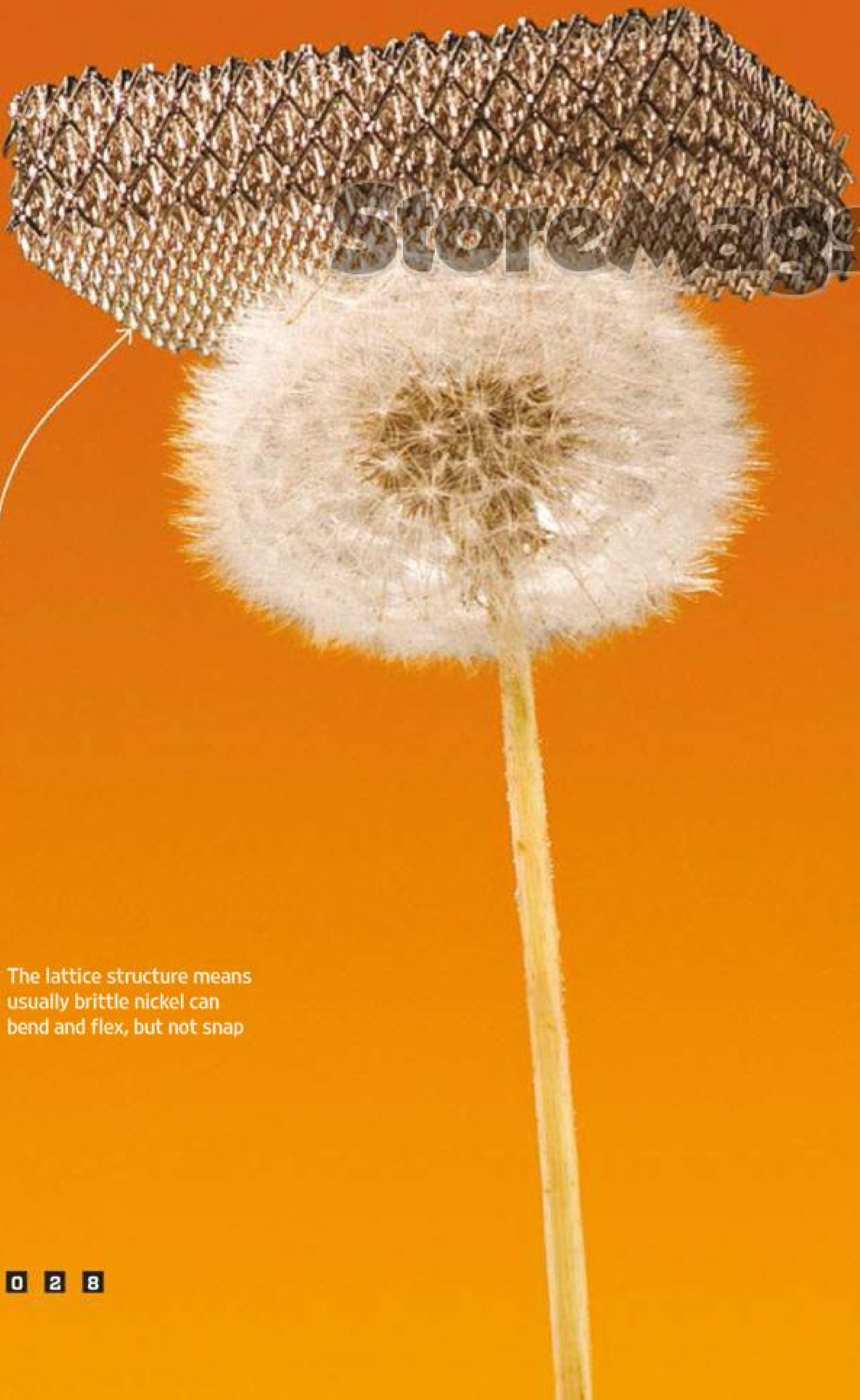
It's a bit of a lightweight

The elegant architecture of the Eiffel Tower has enabled the creation of a superlight material

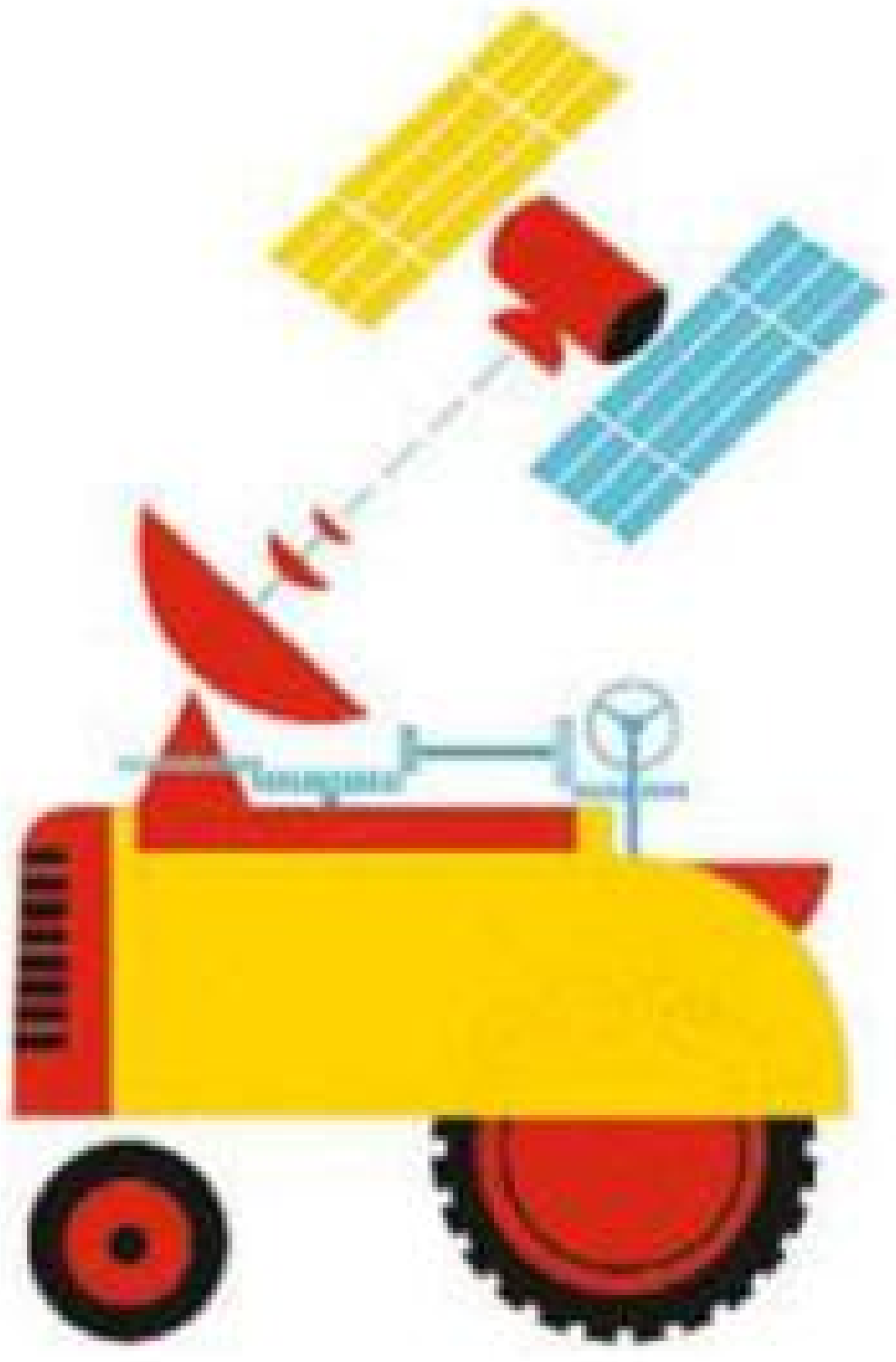
This metallic micro-lattice is strong and springy, yet weighs 100 times less than Styrofoam. It was developed by the Architected Materials group at HRL Laboratories, an R&D facility owned by General Motors and Boeing in Malibu, California. Group manager Bill Carter can attest to its amazing lightness: "If you drop a piece from shoulder height, it takes between five and ten seconds to float to the floor."

The material is made up of hollow nickel tubes, each with walls just 100 nanometres thick, so it is 99.9 per cent air. Its lattice structure gives rise to unique mechanical properties, such as almost complete recovery from 50 per cent compression and high levels of energy absorption. The micro-lattice could find use in structural components for cars and planes, thermal insulation, acoustic damping and batteries.

"There is conjecture [about applications] but the key is that we've developed a scalable way to make ordered architectural structures at the micro- and nanoscale," says Carter. "Nobody has been able to do super-low-density materials with a lattice structure before, because they didn't have a way to make it." **Daniel Cossins**



The lattice structure means usually brittle nickel can bend and flex, but not snap



TREND SURFING

FARMERLESS FARMING

Kinze Manufacturing recently unveiled its autonomous planter – a tractor capable of working without a human operator. And researchers at the University of Leuven have developed a GPS-guided self-steering tractor that adapts to different terrain conditions. No word yet on battery-operated sheepdogs, though.

PROPS GET A SEQUEL

Items used by film, TV and theatre crews in New York are getting a second life thanks to Film Biz Recycling, a not-for-profit that collects and resells everything from faux food to vintage luggage. The same goes for retailers' props: decorative materials are resold by yoused.nl for reuse from shop floor to living room.

DIGITAL DETOX

Guests checking in to the Lake Placid Lodge in New York Adirondacks region are encouraged to surrender their digital devices at the front desk. Or for those wishing to create their own internet-free zones, Afshin Mehin and Hugo Eccles' Social Bomb jams the signal of anyone online within a 30-metre radius. **Liesbeth den Toom**

PHOTOGRAPHY: DAN LITTLE. ILLUSTRATION: ANGUS GREIG

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LAB NOTES #15

We've all met people who are too self-assured, and others with no backbone at all. So what's the optimum level of confidence for success? According to recent research, it's moderate overconfidence that what we should be aiming for.

Overestimation of ability raises utility by deluding people into believing they are more able than they are. Moderate overestimation leads people to choose tasks that raise expected output.[1]

If you have trouble hitting a balance, err on the side of too confident: results confirmed that proud individuals not only took on a dominant role within a group task, but also were perceived as the most likeable.[2] It's especially true for men, with both sexes agreeing men shouldn't be modest. Modest male applicants in staged interviews were less liked.[3]

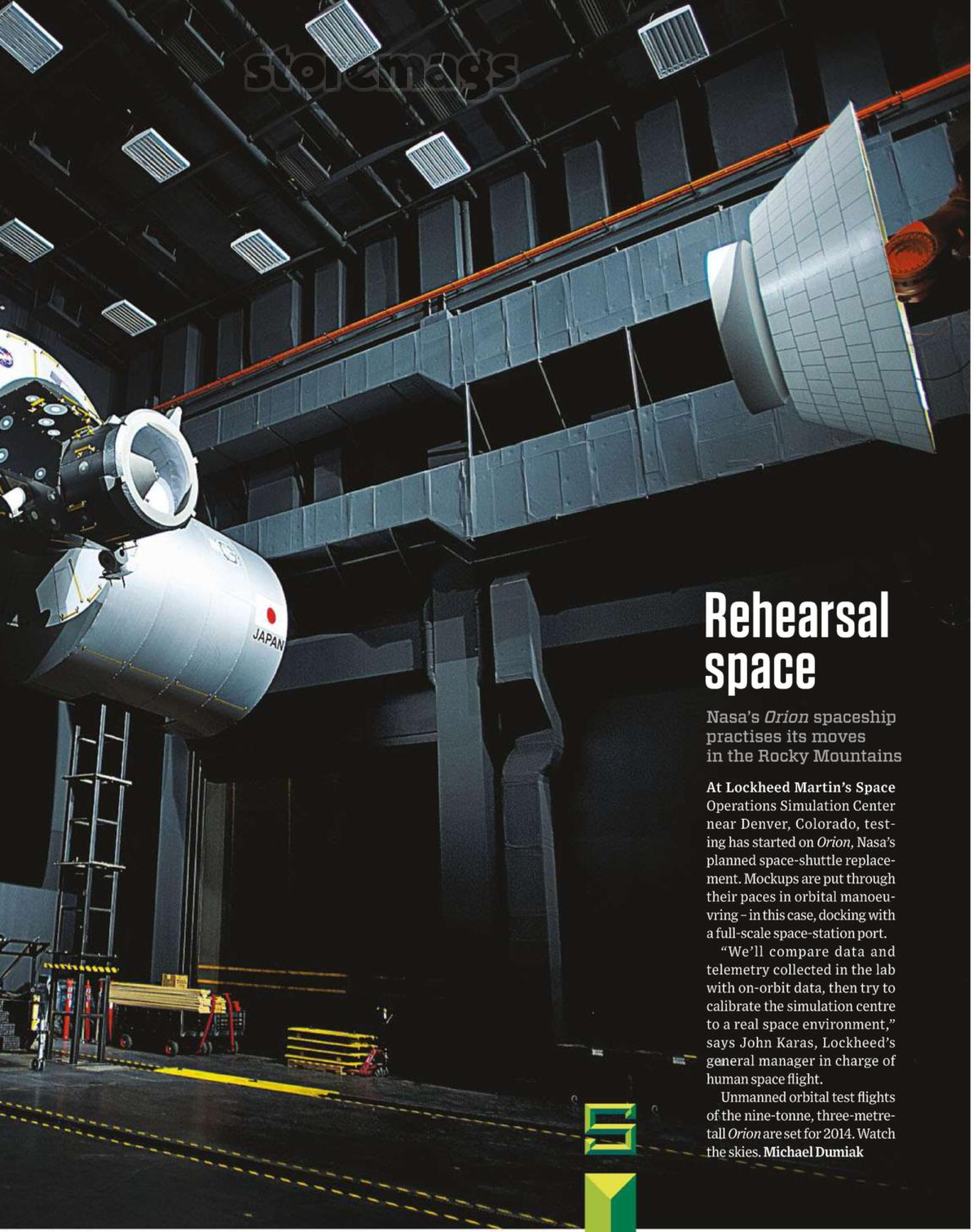
But if you're not feeling up to it, spouting positivity into the mirror won't help. Reassuring yourself only works if you don't need to be reassured: among participants with low self-esteem, those who repeated a positive self-statement felt worse than those who did not repeat the statement.[4]

Sit up. Experiments showed that "when individuals were placed in high- or low-power roles while adopting an expansive or constricted posture, only posture affected the implicit activation of power, the taking of action and abstraction."[5] **Eric Barker** *bakadesuyo.com*

For sources, see page 134

esa
COLUMBUS

PHOTOGRAPHY: MATT NAGER
ILLUSTRATION: DALE EDWIN MURRAY



Rehearsal space

Nasa's *Orion* spaceship practises its moves in the Rocky Mountains

At Lockheed Martin's Space Operations Simulation Center near Denver, Colorado, testing has started on *Orion*, Nasa's planned space-shuttle replacement. Mockups are put through their paces in orbital manoeuvring – in this case, docking with a full-scale space-station port.

"We'll compare data and telemetry collected in the lab with on-orbit data, then try to calibrate the simulation centre to a real space environment," says John Karas, Lockheed's general manager in charge of human space flight.

Unmanned orbital test flights of the nine-tonne, three-metre-tall *Orion* are set for 2014. Watch the skies. **Michael Dumiak**

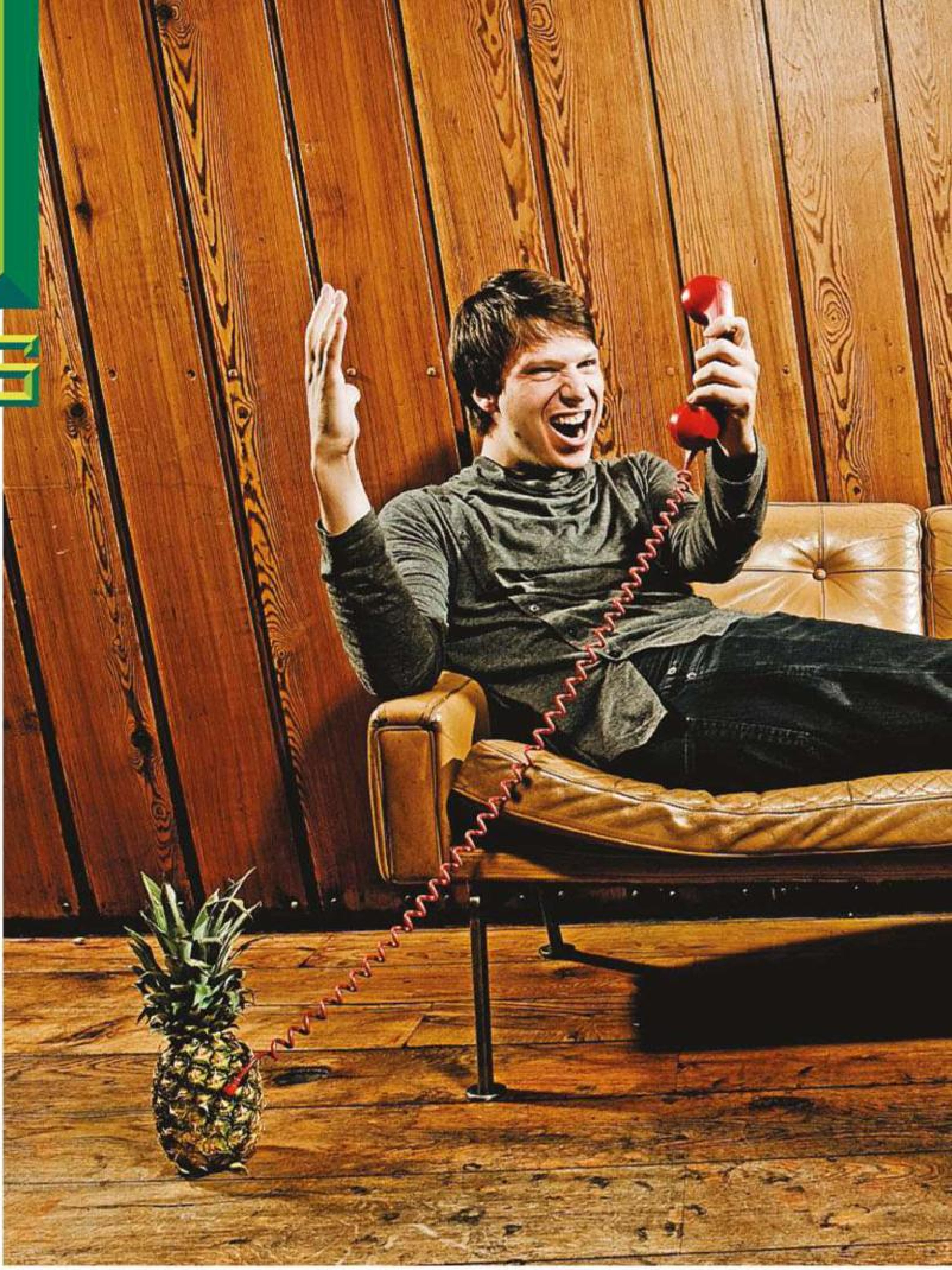
JARGON WATCH

NARB
n. Coined by the academic Anandra Mitra, this blend of "narrative" and "bit" refers to data, such as status updates on social-network sites or Flickr uploads, that add to a user's "personal narrative".

GHOST BIKE
n. A bicycle painted white and locked to a fence or post near the scene of an accident that killed a cyclist. These memorials remind motorists to be aware of cyclists, and cyclists to take care when riding.

QUADROCOPTER
n. A helicopter-like flying machine that uses four rotating blades. Compact and relatively stable in flight, they are suitable as unmanned aerial vehicles (UAVs) or drones – some can be piloted via iPhone.

IKEA EFFECT
n. Feelings of pride for an object that has been self-assembled. "Ikea Effect" can also refer to consumers seeing cheap furniture as disposable, and simply binning theirs every couple of years.
Paul McFedries



This number will self-destruct

Vox.io has created a URL-based alternative to the telephone

"Phone numbers are dead," says Tomaž Štolfa, CEO of Vox.io, a free voice and video-calling service. "If you didn't have a 130-year legacy of traditional telephony, where would you build a brand-new communication service?" Vox.io has the answer: the web.

Vox.io lives in your web browser, and unlike Skype you don't have to download an app. Users receive a URL, which they can link to their existing phone number. So, to call Štolfa, just Google "call Stolfa" and hit the green button on the first link – his Vox.io profile – and you'll be put through. "I travel and I don't need to send my latest phone number to anyone," says Štolfa, 29. "You can reach me straight through my profile, wherever I am in the world." Users can create disposable URLs to send to people they need to

PHOTOGRAPHY: TIMMO SCHREIBER. ILLUSTRATION: MITCH BLUNT

speak to just once. "This creates a new model: disposable telephony. You could buy a Vox.io link to expire in 14 days, say if you were selling a car on Craigslist, and that would cost you maybe 30 pence. The world changes when you don't pay for the communication."

Štolfa founded Vox.io in Slovenia in August 2010; the company has since moved to San Francisco and was a winner at Seedcamp in 2011. The service now has 100,000 registered users.

"Compare video six years ago," says Štolfa. "You got an email attachment, downloaded it, then played it on the right media player, all these things just to watch a 30-second clip. Now, you just send a link to the other person. We're doing the same to communication." **TC** *vox.io*

Name: **TOMAŽ ŠTOLFA**
Occupation: **FOUNDER AND CEO OF TELEPHONY SERVICE VOX.IO**
Location: **SAN FRANCISCO, US**
Need to know: **HIS COMPANY IS RETHINKING TELEPHONY BY BUILDING IT FOR THE WEB**

FLOAT YOUR CARDBOARD BOAT

Cardboard: great for packaging, excellent for building North Sea-going boats. Well, it is if you ask 30-year-old Dutch artist Filip Jonker. "Cardboard isn't the most suitable ship-building material as it isn't water resistant," he explains. "But if treated and protected, a world of opportunity opens." His boat, the 7.5 x 2.8 x 2.6-metre *De Furie*, is named after the tugboat in Jan de Hartog's 1940 book *Hollands Glorie* (published in English as *Captain Jan*). But unlike its namesake, this *De Furie* is constructed entirely out of standard honeycomb cardboard and fitted with a 33-horsepower diesel engine.

It took four months to build, using wood glue and a 4mm-thick coating of heavy-duty paint normally used on gas pipes. In September last year, Jonker set sail on a nine-day trip from Enschede in Holland to London. Crossing the sea took 22 hours.

"The day after we set off to Ramsgate, the weather turned bad, but we'd gone beyond the point of return. Because we were so light, I had to put counterweights in the keel. This caused the boat to behave like a rocking chair, as all the weight was on the bottom. We rocked for 21 hours and were black and blue from bashing into the boat." But at least there were no nasty papercuts.
Matt Hussey *filipjonker.nl*

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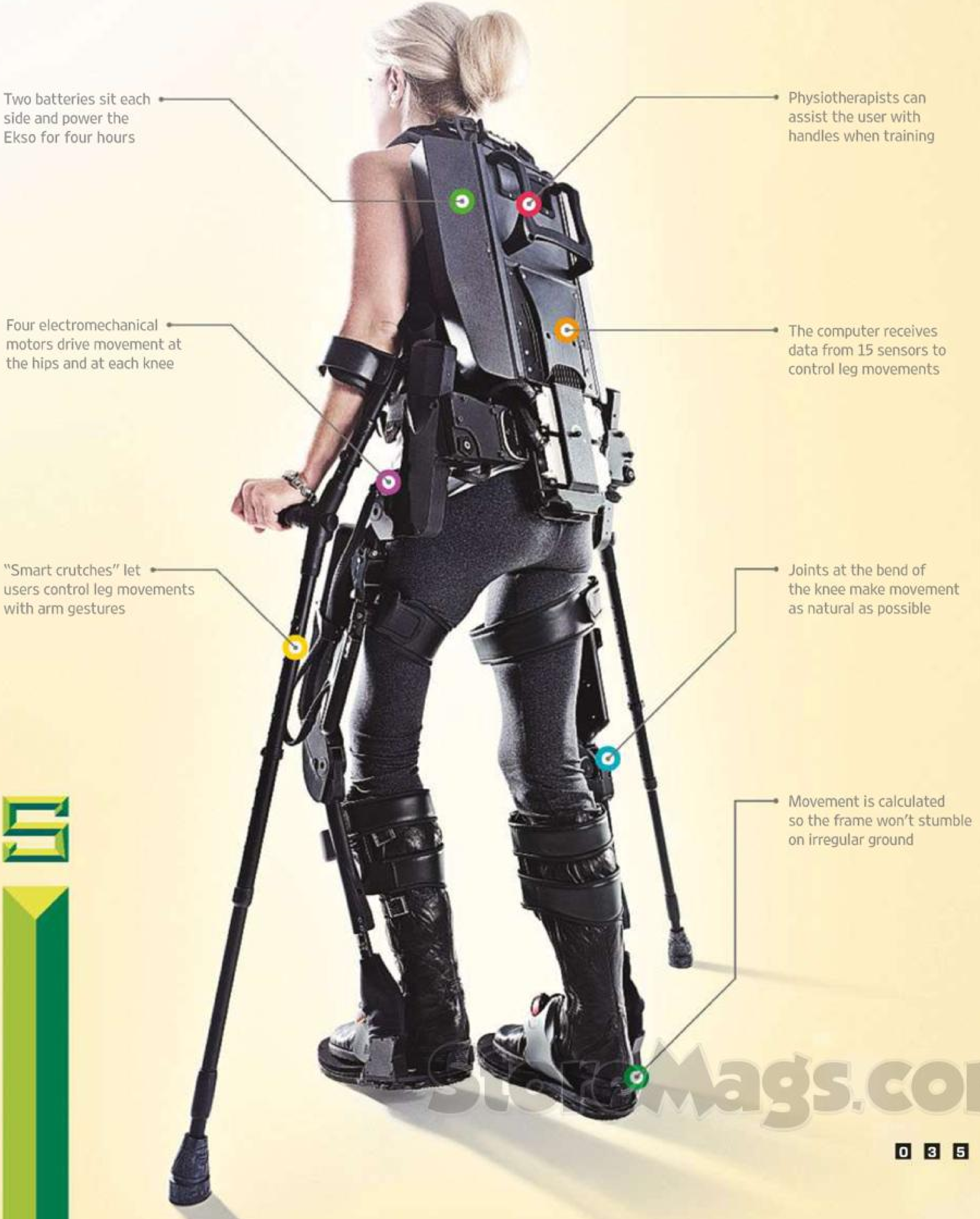
Step by cybernetic step

Farewell to the wheelchair – now a wearable robot puts paralysed legs through their paces

"This is the true integration of man and machine," says Eythor Bender, CEO of Ekso Bionics, a Californian research lab that has developed an intelligent "wearable robot". Bender and his team based the Ekso on a decade of bionics research by the US military. Its motorised leg braces let soldiers carry 90kg loads over long distances by anticipating the wearer's movement and transferring weight to the exoskeleton frame. The same principles allow paraplegics to walk with motorised legs, by responding to gestures made above the waist. Its adjustable titanium frame encases the legs, with straps around the waist, shoulders and thighs, and a computer with two batteries sits as a backpack, powering four electromechanical motors that propel the legs. An intelligent algorithm responds to gestures, making use of 15 sensors: as weight is shifted on to one crutch, the leg on the opposite side steps forward accordingly. Bender claims this is just the beginning, and in time lighter, more versatile Eksos will be developed. "We're taking it step by step." **Jeremy Kingsley** *eksobionics.com*

Below: Amanda Boxtel, permanently injured while skiing, wears Ekso


Two batteries sit each side and power the Ekso for four hours
Physiotherapists can assist the user with handles when training
Four electromechanical motors drive movement at the hips and at each knee
The computer receives data from 15 sensors to control leg movements
"Smart crutches" let users control leg movements with arm gestures
Joints at the bend of the knee make movement as natural as possible
Movement is calculated so the frame won't stumble on irregular ground

PHOTOGRAPHY: JAMES DAY

The home you download

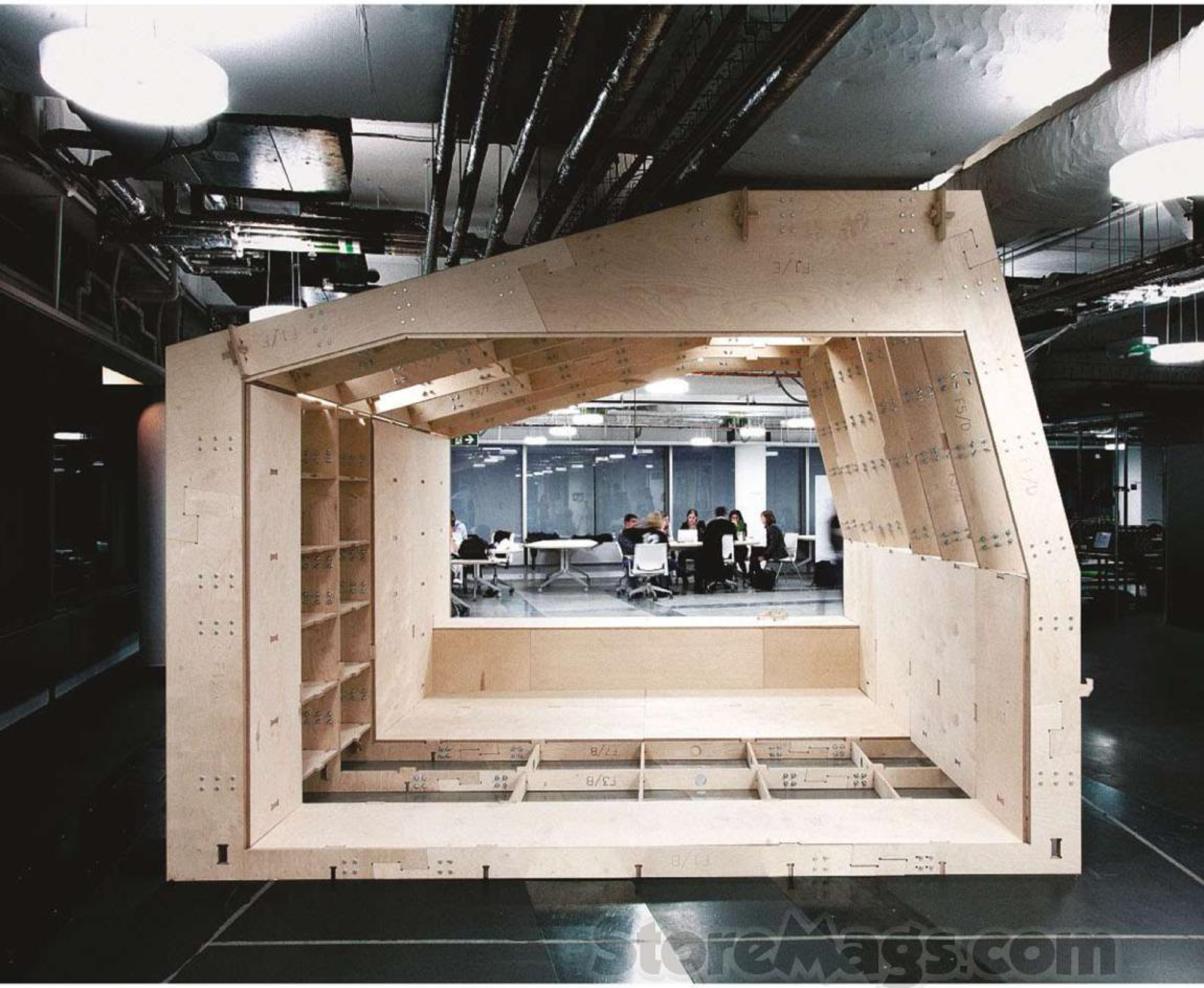
Need somewhere to live? WikiHouse's DIY kits are the open-source way to build a house

WikiHouse is the ultimate self-assembly kit: an open-source construction set that lets you build your own home from online templates. Download the plans, source the parts and get building – your new home can be up by dusk. The designs require no formal skills: assembly is a 3D jigsaw, with numbered pieces that slot together and are hammered down. And there's no need for power tools – even the included mallet is computer numerical control (CNC) milled.

Alastair Parvin, architect at 00:/, the London design practice behind WikiHouse, says the logic of economist John Maynard Keynes ("it's easier to ship recipes than cakes and biscuits") applies to these homes. By putting design into the public domain, WikiHouse hopes to incite real change. "That's the ambition of the project," says Parvin. "To lower the threshold to making your own house."

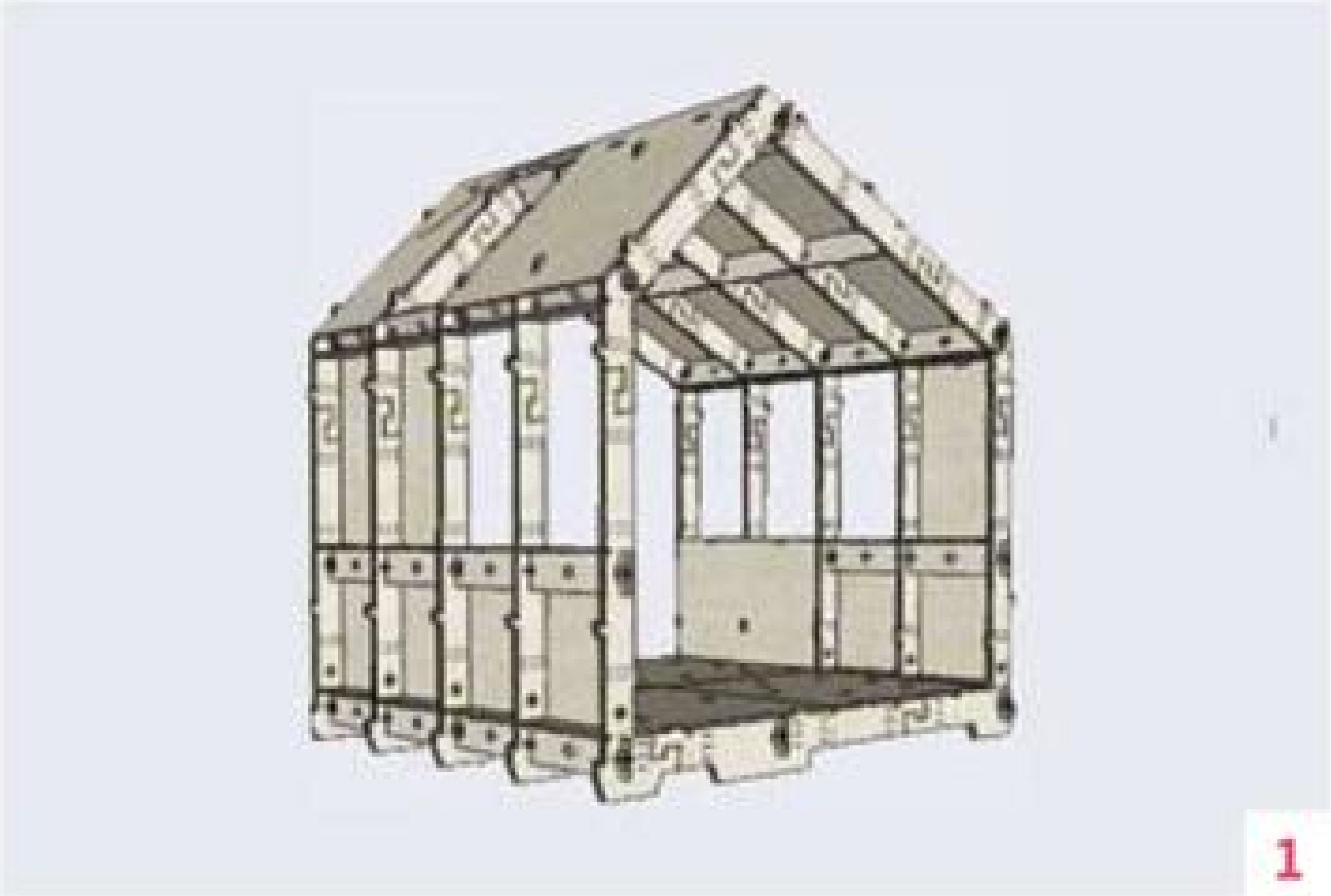
00:/ built its first WikiHouse at the Gwangju Design Biennale in South Korea last summer, followed by another at the October launch of Hub Westminster, a work space jointly run by 00:/ and Westminster City Council for like-minded entrepreneurs to meet and foster collaboration. Having milled the parts (WikiHouse's Google SketchUp plugin lays out the components, which you can mill from plywood panels), a ten-strong team constructed the house.

The practice is exploring using the model for post-disaster recovery, where for speed and cost WikiHouse principles could be invaluable (including sourcing materials from debris). "Everything we do is self-consciously experimental," says Parvin. "It's about finding out what problems are worth solving. And we think this is definitely one of them." **Jeremy Kingsley** *wikihouse.cc*



PHOTOGRAPHY: CHRISTOFFER RUDQUIST

1 The London prototype is loaded on to Google SketchUp
2 The CNC-cut parts, from 18mm plywood
3 Assembly: pieces are numbered in the order they're needed
4 Seven standing sections will be set at 550mm intervals
5 Pieces fit together like a 3D jigsaw
6 Cladding panels are put in place, and it is ready for wiring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HAIL THE TAXI APP

The first Hackney carriage was licensed in 1662; the last major innovation in the sector was the internal-combustion engine. Yet suddenly, the location-enabled smartphone is prompting startups north *and* south of the river to upgrade the taxi experience. WIRED picks five products making the long way round a little shorter. TC

KABBEE

"The black-taxi model hasn't really changed since hailing a horse and cart on Piccadilly," says Phil Makinson. He's the business development manager for *Kabbee*, an Android and iPhone app for booking taxis. It locates you, then aggregates minicab fleets around you to give a quote. *kabbee.com*

UBER

This San Franciscan startup provides cars to anyone with a mobile: cars should arrive in five minutes and cost about 1.5 times the price of a normal cab ride. Behind the app is a lot of tech: Uber employs 33 people, including a computational neuroscientist and nuclear physicist. *uber.com*

HAILO CAB

Jay Bregman, CEO of Hailo Cab, estimates that taxis lose £25 million every day by people not being able to find a car. *Hailo* aims to fix that, with an app "developed for cabbies by cabbies" (three of Hailo's six founders are ex-black cab drivers). Works like *Kabbee*. *hailocab.com*

TWEETING TAXIS

Twitter lets cabbies self-organise: *@gamesdead* provides traffic updates such as "S cabup Chelsea bri mashed back to lwr sloane" for his 70 mainly cabbie followers; *@belgiancabby* tells his 348 followers about speed guns on Constitution Hill westbound and the iPhone 5's mooted release date.

ADDISON LEE

Addison Lee runs the biggest car fleet in Europe, but just eight controllers plot 25,000 journeys a day. How? Using "The Allocator" – a proprietary piece of software that assigns jobs by looking 20 minutes into the future. Its app version made £20 million in revenue last year. *addisonlee.com*

Children's programming

You're not too young at 12 to start an app empire

Twelve-year-old Puck Meerburg (*below*) from Delft, Holland, is an app developer. Since 2010 he has published seven apps for the iPhone and iPad, including a guide for the Netherlands' oldest museum, the Teylers in Haarlem.

"My dad had got an iPhone and I was interested in how you wrote apps for it," he says. "So I downloaded the software development kit. I had already written a web app called *TafelTrainer*, which helps kids learn their times tables, so I turned it into something for the iPhone."

Meerburg taught himself JavaScript, PHP and the JavaScript library resource jQuery when he was "about seven or eight". *TafelTrainer* was followed by a card-game app called *4 Kings*, and last October he launched *The Quizzer*, an app that links an iPad and some iPhones into a general-knowledge quiz.

His apps – mostly free, with the exception of *TafelTrainer+* and *The Quizzer* – were downloaded about 75,000 times in 2011. His ambition is to be a games designer – like his idol, *Minecraft* creator Markus "Notch" Persson. "In ten years, computers will be super-fast," he says. "We'll be able to play games using brain sensors." Meerburg, who plays piano and is learning Arduino, is also becoming something of a pundit, appearing on Dutch television and at conferences such as SIME in Stockholm and TEDxYouth in Amsterdam. "It's fun to be asked about the apps," he says. "But I like programming best." **David Baker** *puckipedia.nl*

Name: PUCK MEERBURG
Occupation: APP DEVELOPER
Location: DELFT, HOLLAND
Need to know: HE'S GOT CODING IN HIS BLOOD – AND HE'S ONLY 12 YEARS OLD

PHOTOGRAPHY: DAN BURN-FORTI.

BUILD AN EYE-TRACKING SYSTEM ON A £30 BUDGET

"The brain's components are basically cheap crap," says 37-year-old Aldo Faisal, a lecturer in neurotechnology at Imperial College, London. "It runs on electricity but, instead of copper wires, it uses salt water. And yet it manages to do amazing things."

Cheap components are Faisal's stock-in-trade, and he has dedicated himself to solving complex problems at minimal cost. His latest project, developed alongside undergraduates in his department, is an ultra-low-cost eye-tracking system. "Most eye-tracking systems cost around £30,000," he says. "Ours works just as well for a thousandth of that."

The team attached two £10 cameras, usually found in video-game consoles, to a pair of spectacles. As the user moves his or her eyes, the cameras register each iris's movement and sends the data to a PC. Right now the students are playing *Pong* with their eyes, but in the pipeline is technology that could control a wheelchair. "The two cameras capture the depth as well as the direction of where someone is looking," says Faisal. "You could use your eyes to trace a path, and then the wheelchair would move accordingly."

Faisal has had approaches from VCs, but he wants a maverick investor. "We are looking for a commercial partner who embraces the idea of making everything cheap, so everyone can use it," he says. "I am not doing research to make money." **David Baker** *faisallab.com*

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A nuclear family ride

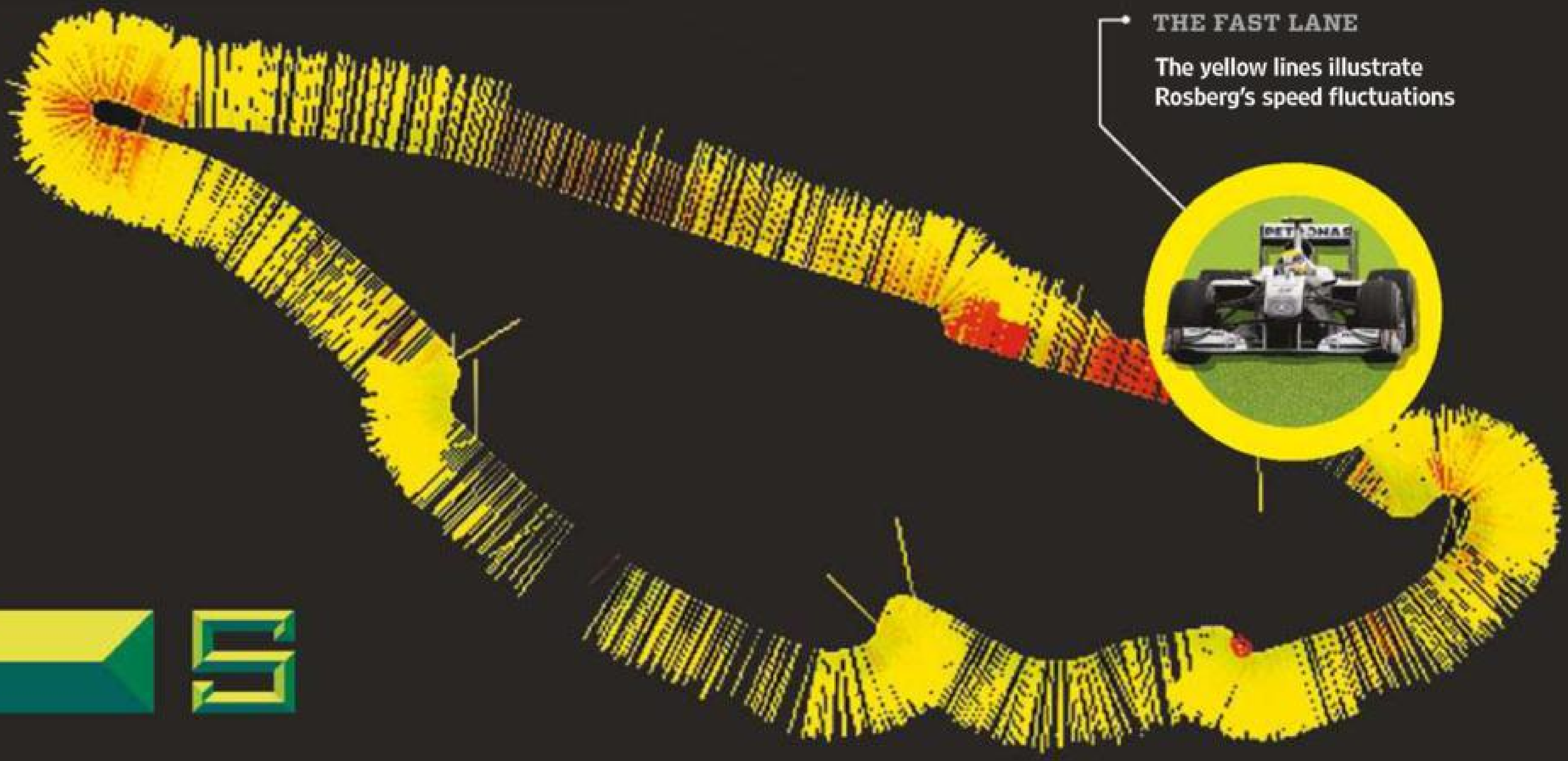
Dizzy spells guaranteed at Germany's atomic park

Kids trapped indoors by cold weather are prone to meltdown. But some German parents will soon be able to go nuclear on them – by taking them to an indoor amusement park at a 327-megawatt atomic energy plant. It's called Wunderland Kalkar, and it's built on the remains of SNR-300, a shuttered fast breeder north of Dusseldorf. But don't worry about getting a green glow: SNR-300 was never active – construction problems and protests kept the plant from opening. Dutch entrepreneur Hennie van der Most stepped in and bought the complex for a rumoured €2.5m (£2.15m) – quite a discount from the €3.5bn it took to build it. The new park features more than 40 attractions, including this swing ride in the cooling tower. The main reaction? Fun. **Sarah Filippi**

Race tracking

It's petrol-head heaven: real-time Mercedes F1 data that maps every throttle, brake and high-speed turn

Obsessive fans of **Formula 1 driver Nico Rosberg know he can race at over** 330kph, pull almost -5G under braking and thrash his engine to some 21,000rpm. They know this because, throughout 2011, the Mercedes GP Petronas team has displayed live data – including G-force, steering-wheel angle, and brake and throttle pressure – from its racing cars on its website. Rosberg's speeds in the qualifying session for the Canadian Grand Prix in June are shown below; each pixel represents speed plotted against distance. The higher the speed, the longer the line. It's a victory lap for live data. **DS** *mercedes-gp.com*



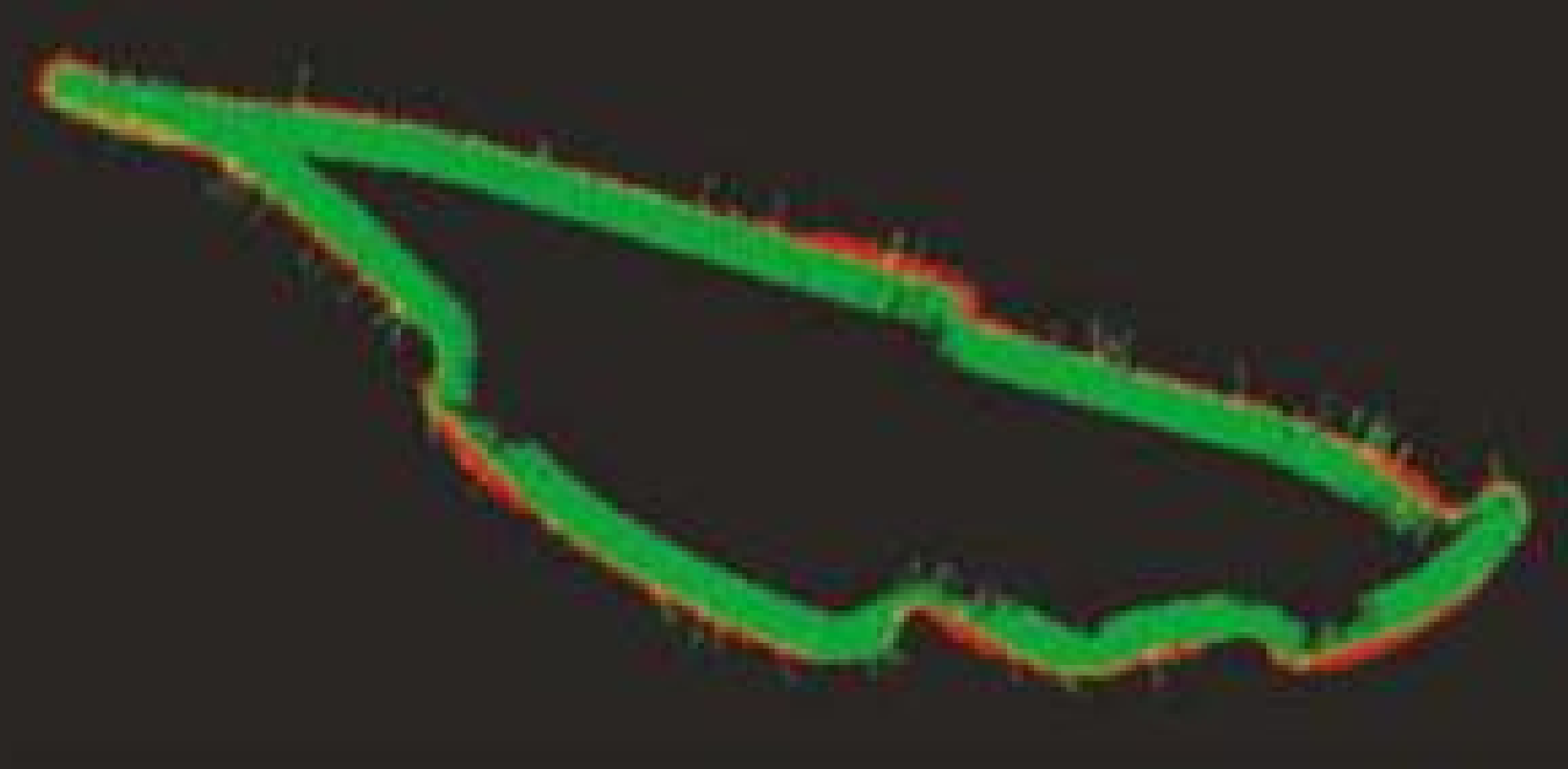
THE FAST LANE

The yellow lines illustrate Rosberg's speed fluctuations

BRAKE POWER

Data shows brake and throttle pressure

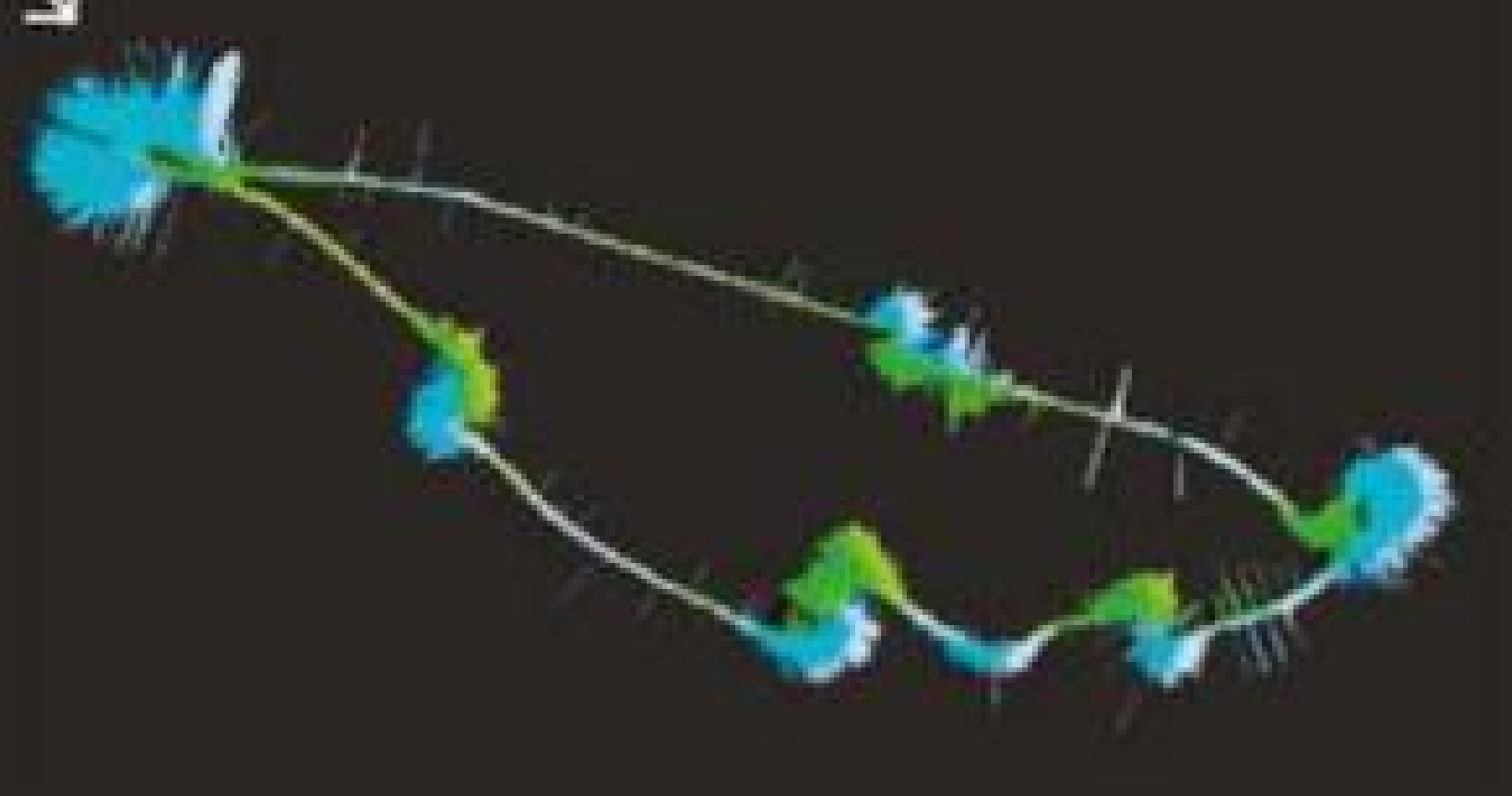
- ● Throttle applied
- ● Brake applied



STEERING WHEEL

Data shows angle of wheel turning left or right

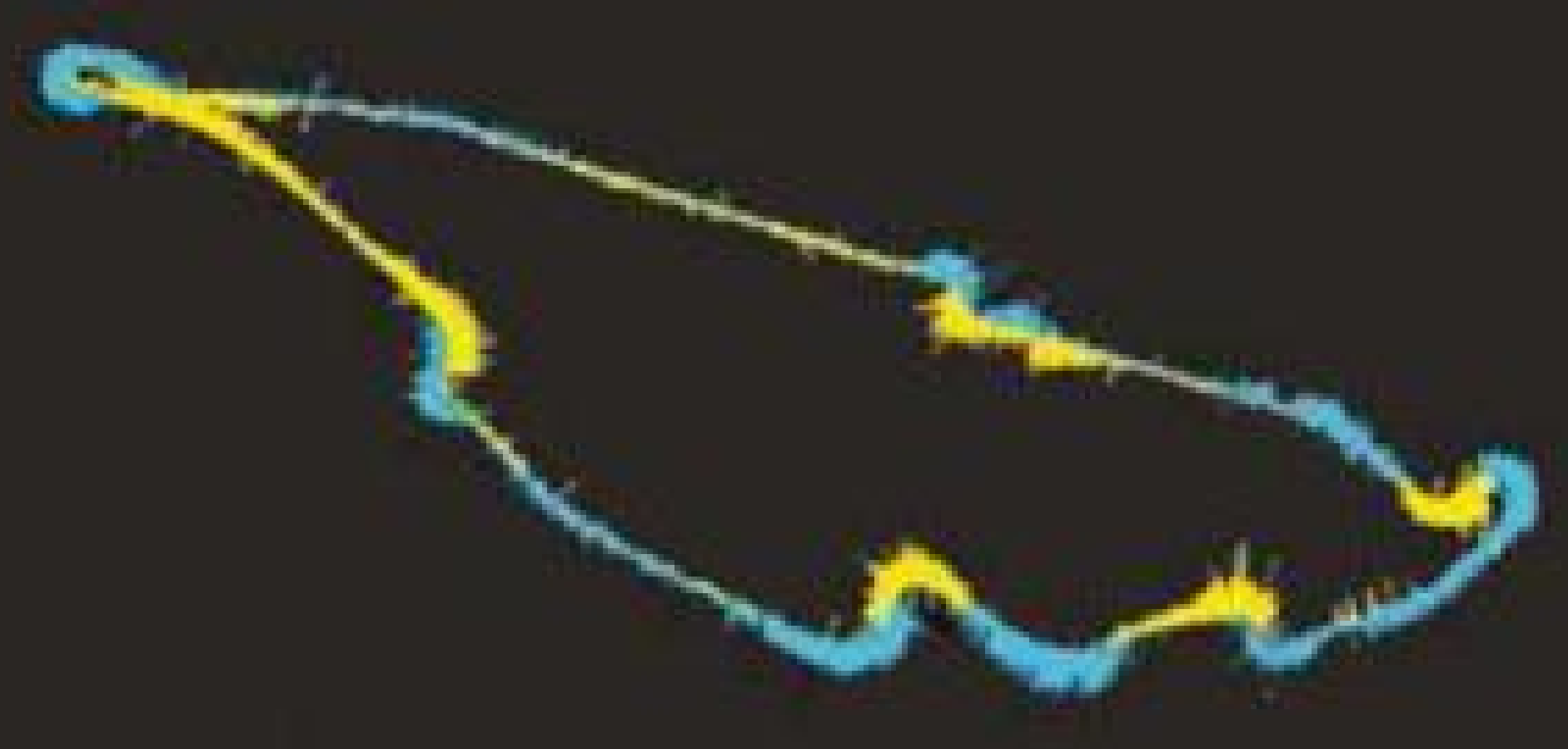
- ● Wheel turning left
- ● Wheel turning right



G-FORCE QUANTITIES

Data shows G-force from -5.552G to 2.108G

- ● Acceleration
- ● Braking



PHOTOGRAPHY: GETTY IMAGES

WIRED	TIRED	EXPIRED
Duqu	Stuxnet	Conficker
Starbucks Bank	Grameen Bank	European Central Bank
Inhalable caffeine	Caffeine soap	Caffeine mints
Parrots	Brown M&Ms	Socks
Surveillance commissioner	Information commissioner	Learning French

WIRED INSIDER

EVENTS, NEW PRODUCTS, PROMOTIONS AND COMPETITIONS TO LIVE THE WIRED LIFE

COMPILED BY TILLY BULL

1 DENON CEOL HI-FI SYSTEM

This hi-fi system is something of a multi-tasker. Play CDs, access more than 15,000 internet radio stations, stream music with an impressively fast broadband connection or play music from your iPod or iPhone via its dedicated dock. And it's eco-friendly – the CEOL's standby power runs at less than 0.4w, eliminating unnecessary power usage. *denon.eu*

2 KOKORICO BY JEAN-PAUL GAULTIER

JPG's new fragrance for men contains bags of panache. Perfumers Olivier Cresp and Annick Menardo joined noses to create a fragrance of fig-leaf, patchouli, cedar, cocoa and vetiver. We also love the glossy red film canister the bottle comes in. Kokorico launched exclusively in Harrods on December 27, and rolls out nationwide on January 11. *jeanpaulgaultier.com*

3 BALBLAIR 2001 VINTAGE

This is the first release of Balbair's new vintage single-malt Scotch. This full-bodied whisky was matured in American oak, ex-bourbon casks, giving it toffee and vanilla notes to complement the aromas of orange, apple and lemon. With no artificial colourings, a balanced flavour and long-lasting finish, it certainly makes an impression. *balblair.com*

4 BREITLING CHRONOMAT GMT

Breitling's Chronomat GMT offers a solution to the bane of jet-setters everywhere – shifting time zones. Simply pull out the crown and twist it backwards or forwards and you are instantly adjusted to the new time and date. An extra, red-tipped hand also maintains a 24-hour display so you'll always be aware what time it is back home. *breitling.com*

5 LENOVO IDEAPAD LAPTOP

The Lenovo IdeaPad comes in a range of colours and is also kitted out with touchpads and widescreen LED displays. Hidden underneath its good looks are some rock-solid features including a 1TB hard disc drive, an optional Blu-ray drive and a thermal management system to keep your kit cool and quiet. *lenovo.com/uk*

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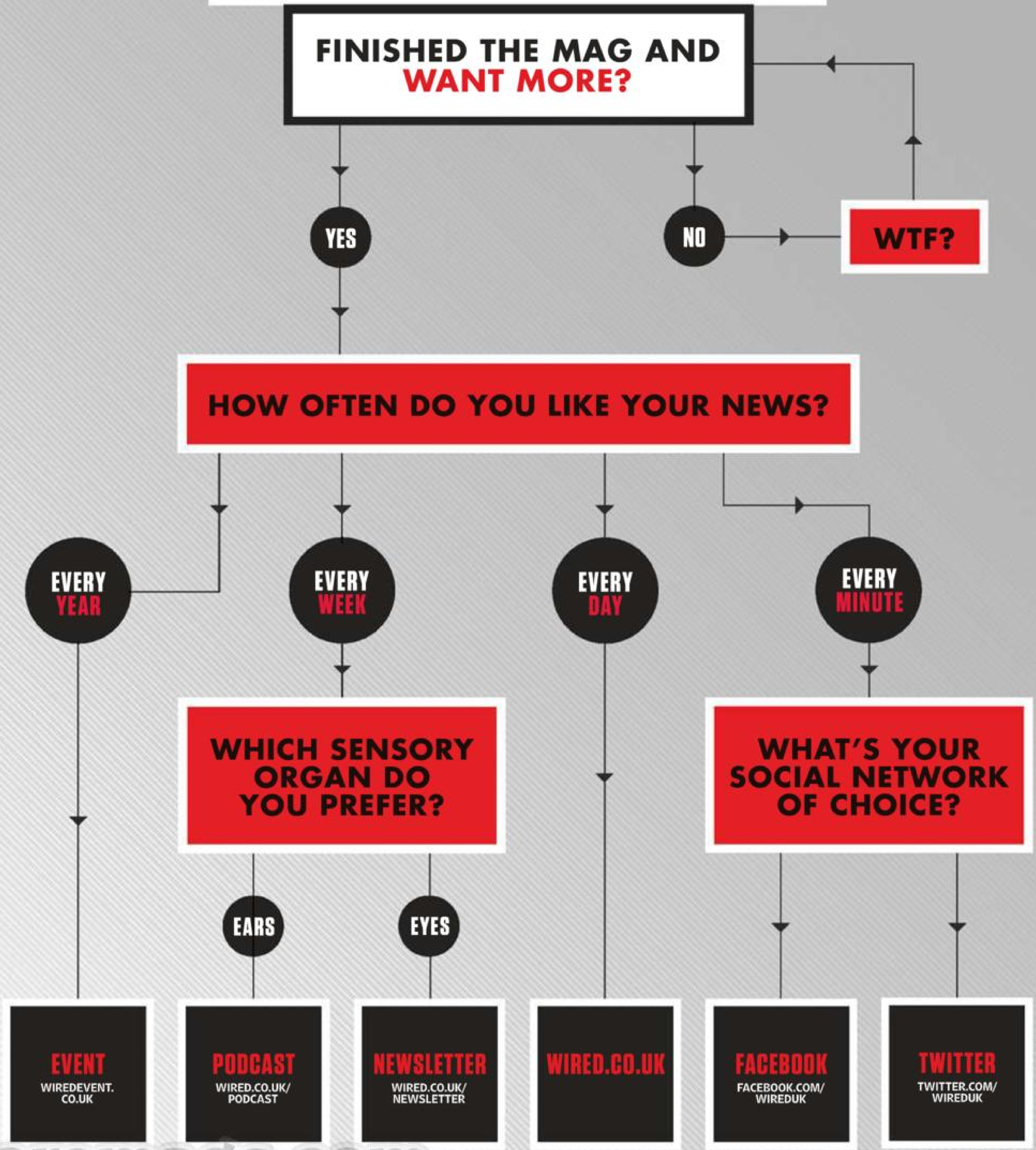
DENON
BALBLAIR
01
Kokorico

PHOTOGRAPHY: WILSON HENNESSY

WIRED.CO.UK



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NO

WTF?

HOW OFTEN DO YOU LIKE YOUR NEWS?

EVERY YEAR

EVERY WEEK

EVERY DAY

EVERY MINUTE

WHICH SENSORY ORGAN DO YOU PREFER?

EARS

EYES

WHAT'S YOUR SOCIAL NETWORK OF CHOICE?

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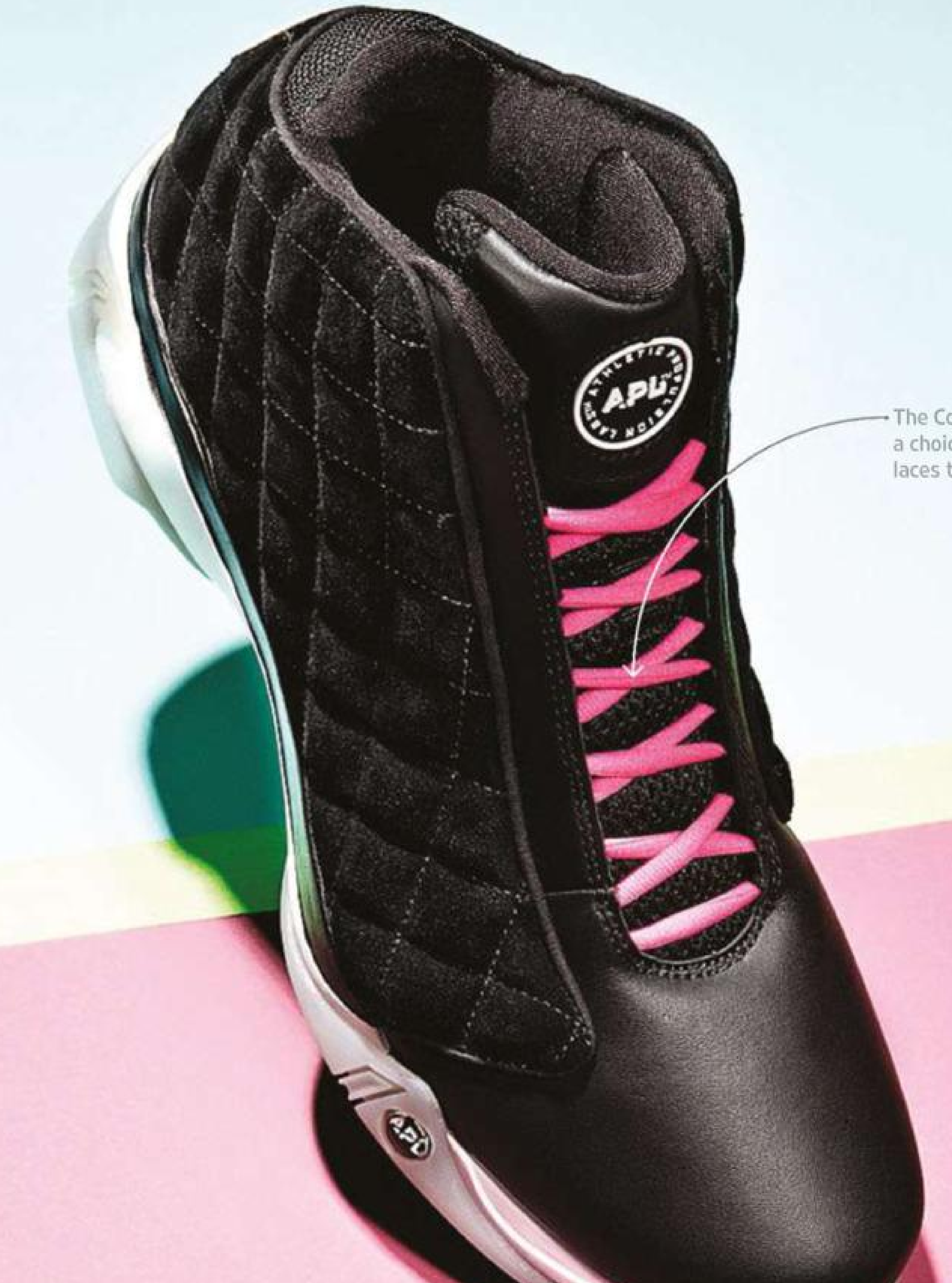
FETISH

OBJECTS OF DESIRE
THIS MONTH: 02.12
- HIGH JUMPING HI-TOPS
- SOLAR-POWERED GRILL
- REINVENTED CHAIR
- RETRO-COOL DESIGN
- STREAMLINED TECH

EDITED BY JIM HILL



The Concours comes with a choice of six coloured laces to match your team

1

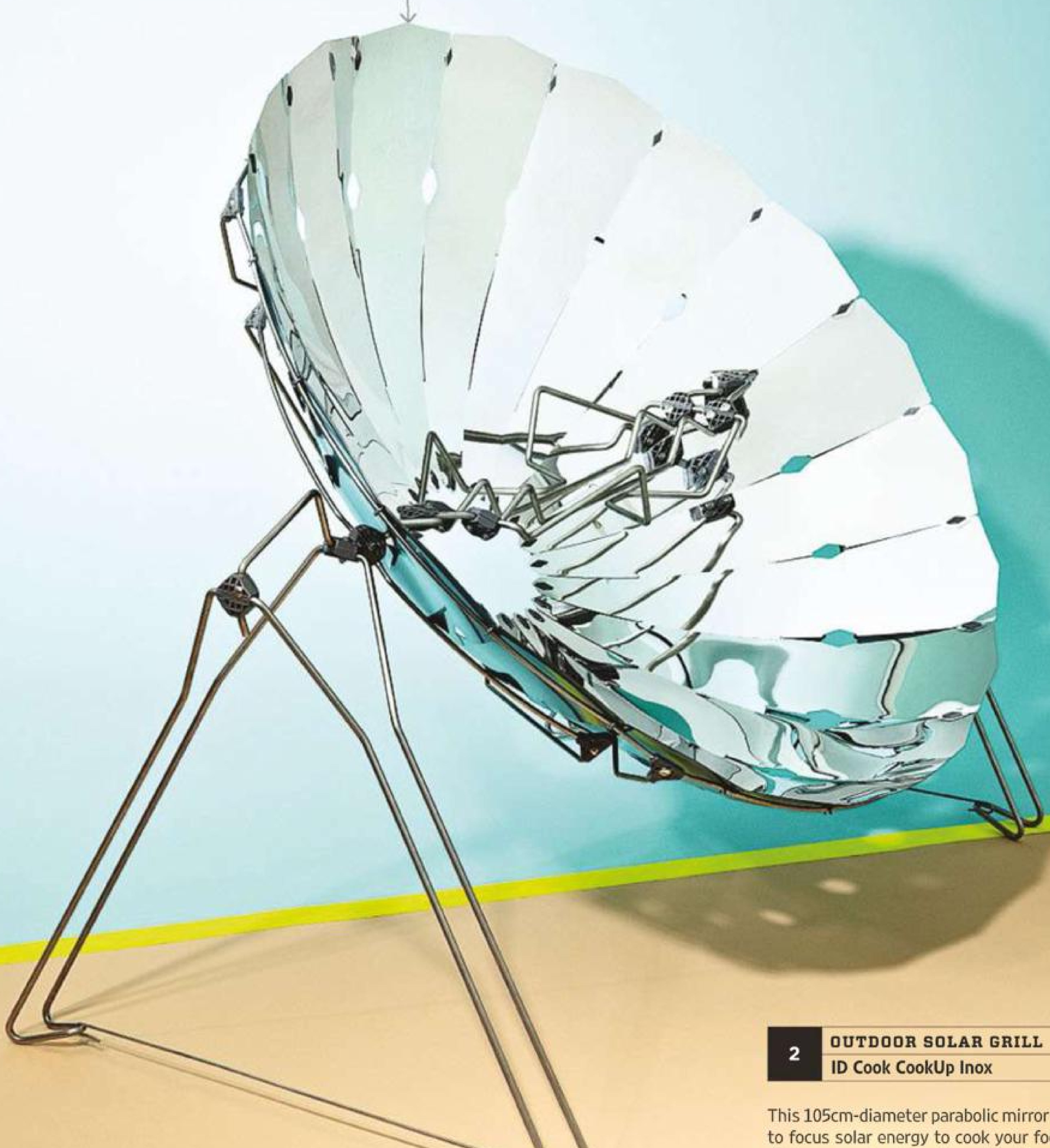
BASKETBALL JUMP-BOOSTER

Athletic Propulsion Labs Concours

The Load 'N Launch pad in the forefoot of these basketball shoes has already been banned by the NBA. It's designed to capture energy from the foot pushing down before a jump, and release it to aid the drive upward – like an in-built spring. The boost can add several centimetres to your hoop dreams. *$195 athleticpropulsionlabs.com*

Stormags com

PHOTOGRAPHY: VICTORIA LING. WORDS: SIMON MUNK



The reflective surfaces on the CookUp Inox are made of polished stainless steel

2

OUTDOOR SOLAR GRILL

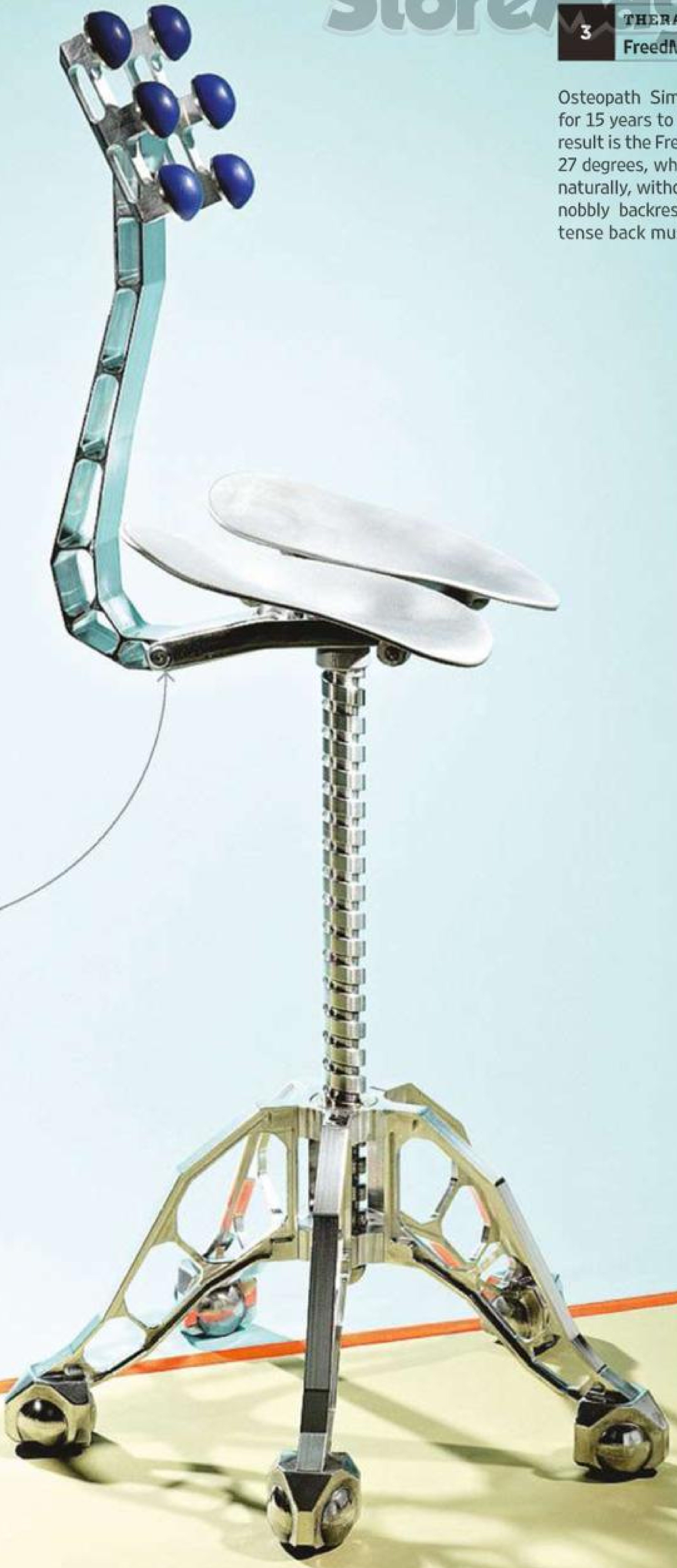
ID Cook CookUp Inox

This 105cm-diameter parabolic mirror is designed to focus solar energy to cook your food. Cooking dishes are placed on the stand in the centre, where they are heated up to over 200°C – if the Sun is shining, of course. When not in use, the smokeless BBQ disassembles into a convenient 105 x 20 x 11cm box. *£261 idcook.com*

3 THERAPUTIC SEATING

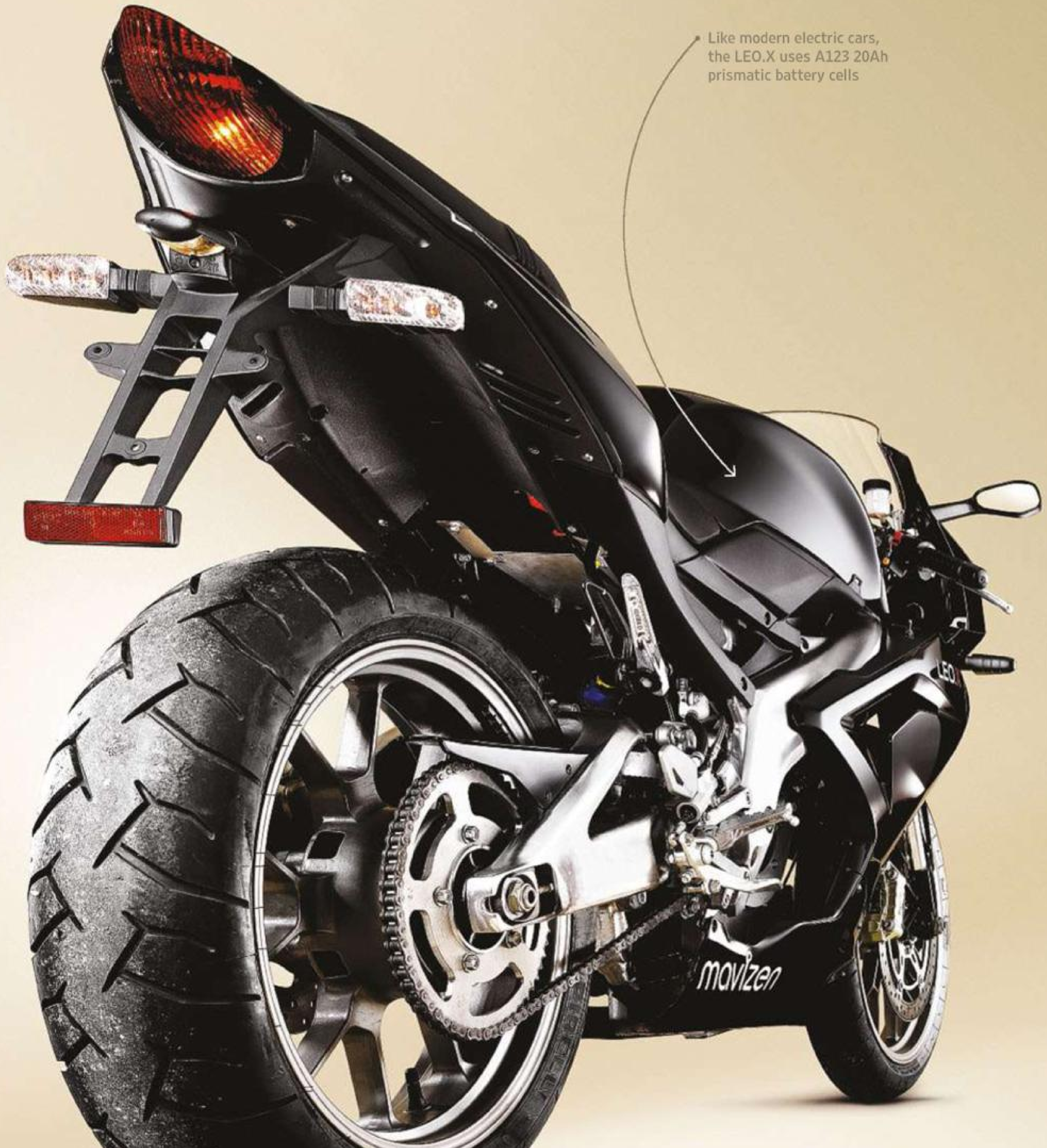
FreedMan Chair

Osteopath Simon Freedman has been working for 15 years to invent the perfect desk chair. The result is the FreedMan. Its seat "pan" is angled at 27 degrees, which encourages the spine to curve naturally, without needing a lumbar support. The nobbly backrest applies theraputic pressure to tense back muscles. *£1,500 freedmanchair.com*



Don't sit still: the chair is designed to encourage position movement

PHOTOGRAPHY: VICTORIA LING.
WORDS: SIMON MUNK


Like modern electric cars, the LEO.X uses A123 20Ah prismatic battery cells
LEO.X
mavizen

1 **ELECTRIC SUPERBIKE**

Mavizen LEO.X

Mavizen, maker of the world's first electric superbike, offers the LEO.X as a road machine along the same aerodynamic lines. It can hit 110kph and travels 80km before needing a charge. It's a kit bike, so battery upgrades are available that can almost triple this range. Buyers take a course in which they assemble their bike themselves before riding it away. *£8,000 learn.egrandprix.org*

2 AERODYNAMIC SHELTER

Senz umbrella

The aerodynamic Senz umbrella is able to withstand winds of up to 100kph. It is designed to turn in to and slice through the wind, rather than get popped inside-out by it. A feature that will be appreciated by passer-by are the "eyesavers" instead of spoke-ends. Since bringing its manufacturing in-house, Senz has improved construction and materials. *From £40 senzumbrellas.co.uk*

3 ELECTRIC WATER-CRAFT

ExoConcept EXO

Think of the EXO as a low-slung, eco-friendly jet ski on which you lie down. Using water jets to propel itself forward, it's nearly silent. Top speed is a decent 50kph, it will run up to 2.5 hours on its rechargeable batteries and comes in ABS plastic or lightweight carbon fibre. Launched at the Cannes Boat Show, it's the ideal runaround to accompany your yacht. *From €7,300 exo-concept.com*

STREAMLINED DESIGN

SLICE THROUGH AIR AND WATER WITH DRAG-FREE EASE

4 CARBON-FIBRE SUPERCAR

Lamborghini Sesto Elemento

At 999kg the Sesto Elemento is the lightest car Lamborghini has produced – it's also likely to be one of the most expensive production cars ever. Limited to 20 vehicles worldwide, this all-carbon-fibre car hits 100kph in 2.5 seconds and tops out at 320kph. Not exactly road-legal, but if you can afford one, you probably also own a race-track. *Approx €1.9 million www.lamborghini.com*

5 MODULAR BIKE HELMET

Giro Selector

The Selector is designed for all-out aerodynamic speed, specifically for time-trial cyclists. The helmet comes with an interchangeable bottom half – designed to ensure the best possible streamlined fit between the tail of the helmet and your back's curve when on your bike. This makes it suitable for a wide range of riders and their cycling positions. *£240 madison.co.uk*

PHOTOGRAPHY: RICHARD MAXTED; ROGER STILLMAN. WORDS: SIMON MUNK

1 ICONIC DESK PHONE

Swissvoice ePure

Designed to look like a phone icon you might find on a computer, the ePure is a cordless DECT digital handset with a 1.4" LCD display, ten hi-fi ringer melodies and a 100-name-and-number directory. Wander 300m from the handset cradle, or add another four handsets for flexible phoning. It also has a 2W loudspeaker for hands-free or shared conversations. *£70 firebox.com*

2 USB MIC

Blue Microphones Snowball

USB microphone, analogue looks – the Snowball is not just a pretty face. It has three recording modes: cardioid, omni-directional and cardioid with a -10dB "pad", so it can handle a variety of sound inputs. If you have an Apple camera connection kit, you can use the cables to link the Snowball to an iPad and record audio directly to apps such as *GarageBand. £90 bluemic.com*

FUTURE RETRO DESIGN

FORWARD-LOOKING TECH WITH AN EYE ON THE PAST

3 TELLING TIME BY TUBE

Nixie Watch

Nixie tubes – a 55-year-old cathode/gas tube technology – make for a playfully retro display. Tilting to view makes the two tubes light up, showing hours, then minutes. Nixie tubes can be fragile, but these are encased in tough aircraft-grade aluminium. And their biggest selling point? Apple cofounder Steve Wozniak wears one. *$430 (inc shipping) cathodecorner.com*

4 DIGITAL RETRO AUDIO

Revo Heritage Radio

The slick 60s styling hides a wealth of 21st-century essentials – RDS, an iPod/iPhone dock, Wi-Fi internet radio, DAB/DAB+ and even Last.fm. A large oled display shows track and station listings; modes are navigated via a small joystick. Best of all, the aluminium and walnut-veneer construction will set off your Teasmaid quite nicely. *£230 www.conranshop.co.uk*

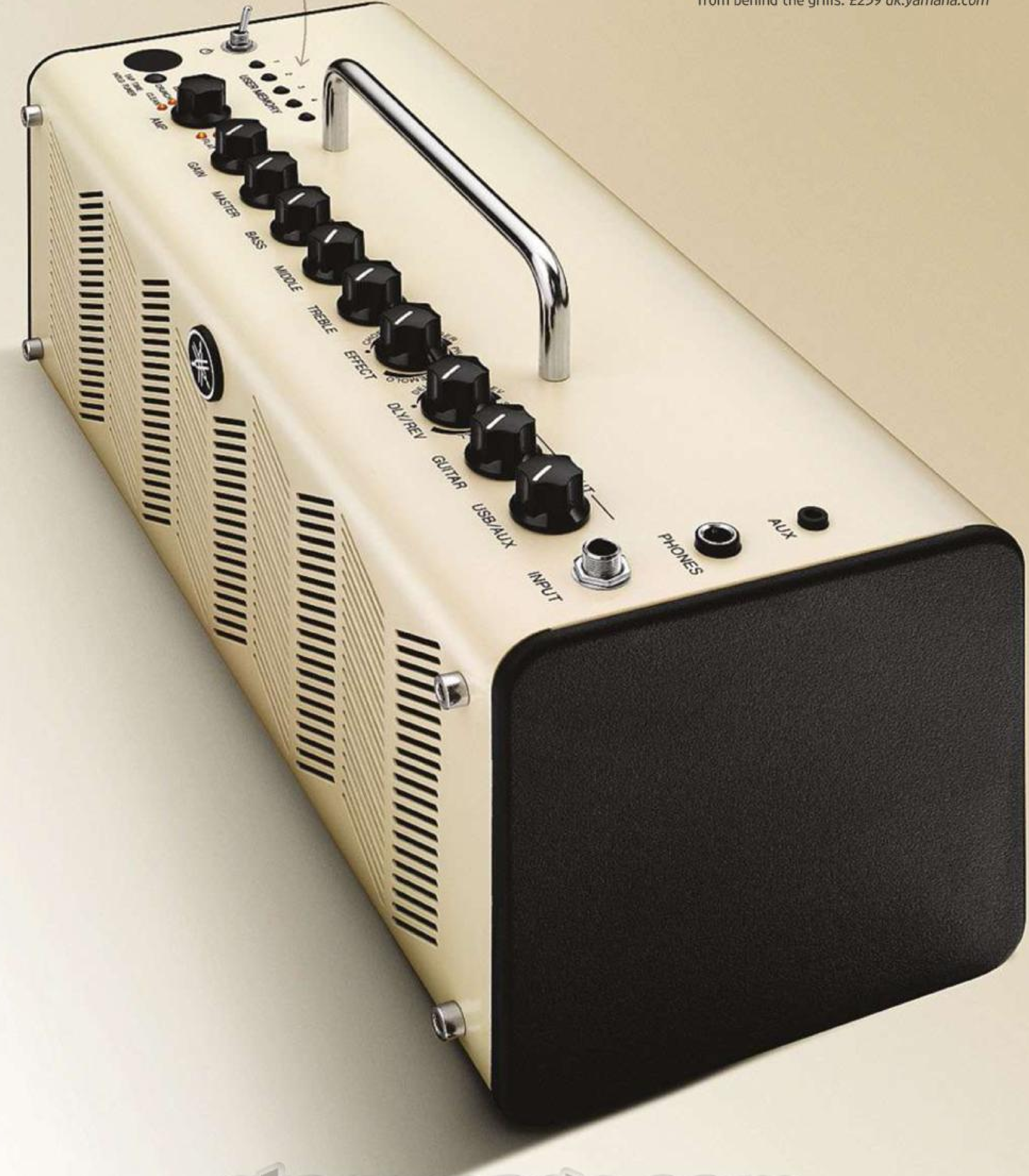
PHOTOGRAPHY: RICHARD MAXTED; ROGER STILLMAN. WORDS: SIMON MUNK

5

OFF-STAGE AMP

Yamaha THR10 amplifier

It's little bigger than a shoebox, but the retro-styled THR10 applies authentic sound effects to your guitar and other instruments. Connections include a USB port, and it can amplify any source through its 5W stereo speakers. Its batteries will give you seven unplugged hours, and fans of old tube amps will enjoy the emulated orange glow from behind the grills. *£259 uk.yamaha.com*


USER MEMORY
AMP
GAIN
MASTER
BASS
MIDDLE
TREBLE
EFFECT
DLY/REV
GUITAR
USB/AUX
INPUT
PHONES
AUX

The user memory can hold five custom controller and switch settings

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IDEAS BANK

BRAIN FOOD AND PROVOCATIONS

THIS MONTH: 02.12

MARK EARLS_BAS VERHART_DAVID HORNIK_JEREMY RIFKIN_ANIL K GUPTA AND HAIYAN WANG_DAVID WOLMAN

MARK EARLS_

The Meg Ryan theory of social conditioning

The romcom movie genre can hardly be described as fundamental to understanding human behaviour. But there is one exception: the Rob Reiner film *When Harry Met Sally* contains probably the most important scene in film history (in terms of behavioural science). And yes, it is the scene in which Meg Ryan fakes an orgasm in Katz's Deli. But it is the response of the older lady at the next table that matters. When Ryan is finished, this character turns to the waiter and says: "I'll have what she's having."

The phrase gets to the core of the essential human talent for "social learning" – learning from the example of those around us. We do it earlier than infants of our fellow primates (as young as 42 minutes after birth, according to one study); we do it better and more accurately; and we keep on doing it for fun, long after our primate cousins have given up.

ILLUSTRATION: STANLEY HOOPER

This is the missing piece in our understanding of human behaviour: whereas cognitive neuroscientists and behavioural economists have shown the primary role of emotion as opposed to rationality in cognition, the importance of I'll Have What She's Having (IHWSH) as a thinking short cut is clearer than ever. Evolutionary psychologists might post-rationalise modern human quirks in terms of the supposed lifestyle of our ancestors, but IHWSH shows us our lives today.

Take last summer's riots: however much politicians and judges stress the moral or psychological pathologies of individuals, most participants emulated what they saw going on unpunished around them – helped by media effectively showing rioting as an exciting pastime.

"Culture" markets such as music, books and films are also shaped by social influence (as Duncan Watts of Yahoo! and Matt Salganik of Princeton University have shown). We mostly choose what those around us choose, whatever we tell ourselves. We do the same with the names we give our children, the dog breeds we select, the neighbourhoods we live in. Nick Christakis and James Fowler's study of the longitudinal health study in Framingham, Massachusetts (WIRED 11.09), revealed the primary influence of our nearest and dearest on individuals' weight gain (you're 63 per cent more likely to become obese if someone in your circle is). It's the people around us who shape our behaviour.

This simple insight builds on much of what psychologists such as Nick Humphrey and anthropologists such as Robin Dunbar (Ideas Bank, 07.11) have shown about the social nature of our brains – they are social-monitoring devices much more than calculators. Think about the "mirror neurons" discovered by Giacomo Rizzolatti and team that entangle our individual brains with those of the people around us.

All of which runs contrary to many of the stories we each tell ourselves. We are not the authors of our own lives. We use other people's bodies and brains to navigate through life, to work out what to do, what to choose and where to go next. Now, what is that guy over there drinking?

Mark Earls, with Alex Bentley and Mike O'Brien, is author of I'll Have What She's Having – Mapping Social Behavior *(MIT Press)*

BAS VERHART_

Education is failing the future-makers

When you're super-smart and want to learn – or simply don't fit the mould – what other choice is there? Some of the world's greatest creative leaders dropped out, found a way to create the type of education they needed, and changed our world.

Edwin Land, cofounder of Polaroid, dropped out to focus on research. In his lifetime he registered more than 500 patents and introduced the world to instant photography. Then there's Buckminster Fuller, certainly one of the geniuses of the 20th century. He dropped out, went back, got bored and dropped out again, then went on to invent the geodesic dome. The late Steve Jobs claimed that dropping out forced him to be more innovative. So why are today's futuremakers dropping out?

1. Society is changing so fast that science-based education can barely keep up, meaning students often know more about subjects than their professors.
2. Instead of looking at absolute truths based on the past (which gives a false sense of certainty), futuremakers imagine scenarios that don't yet exist.
3. Futuremakers are attracted to ideas that fall under the radar instead of what the mass considers reality.
4. Trial and error and a few swerves typify their career path, because they question how others proceed as they shape a future that suits them best.
5. Instead of choosing to pursue a career in a specific industry, futuremakers show more interest in quirky crossovers.
6. Why should you wait to change the world until you gain your degree?
7. Then there's the power of gut feelings. Because futuremakers get a rush out of the next big thing, they are constantly following their instinct for change.
8. Real breakthroughs are much more exciting than incremental changes, so they prefer exploration to predictability.
9. In their quest for a better future, they're more likely to dive into uncertainty.
10. They typically have an explorative and analytical mindset, and are divergent and convergent thinkers.

Perhaps a single educational institution isn't enough – or maybe the concept of an "institution" is all wrong. Maybe these thinkers had to drop out in order to find the various pieces of education, inspiration and experimentation they needed to achieve vision. Today's schools seem to be missing out on teaching "discovery skills", described in *The Innovator's DNA* (Clayton M Christensen et al) as associating, questioning, observing, experimenting and networking. This explains why high-profile dropouts feed their curiosity with events such as TED – they can marvel at the entrepreneur, the crazy scientist, the edgy artist, and be inspired. These are the people with the vision to revolutionise education, creating new schools such as Stanford's D. School at the Institute of Design and meta-universities such as Singularity U.

Does the world need more dropouts? Probably not. But we do need more futuremakers. Imagine what these edgy, creative, crazy minds could achieve if they stayed in school – the right kind of school, that is.

Bas Verhart is cofounder of THNK, the Amsterdam School of Creative Leadership, and a board member of trendwatching.com

DAVID HORNIK_

Nice guys finish first – eventually

I am a venture capitalist. I take other people's money, invest it in exciting little companies, hope those companies get bigger and, if all goes well, return more money to my investors than they gave me. I recently met a financial planner who informed me that his mission was to help me achieve my life's goals. He asked me a string of questions in an effort to understand me as a person, and then asked his final question: "What do you want to achieve with your life?"

I thought about it for a second and told him, "I want to be a successful venture capitalist without being a jerk." He was at a loss. Apparently my answer was supposed to be in dollars. But it was the truth. I'll make my investors plenty of money. But, above all, I want to demonstrate that success doesn't have to come at someone else's expense.

Imagine my horror, then, when I read about a recent study[1] by professors from several leading business schools, including Stanford's, which concluded that nice guys don't finish first. It determined that although nice guys garnered prestige for their upstanding behaviour, the strongest leaders were best characterised by dominance. Those who demonstrated selfish or belligerent traits were ultimately perceived as more dominant and, therefore, better leaders. The converse was also true – the more altruistic you appeared, the less appealing you were as a leader.

The study reminds me of dating. The girls in my school were attracted to the bad boys. Despite the early appeal of the jerks, however, in the end the girls realised that they were better off marrying the nice guys. I think the same is true in business. Selfish, authoritarian leaders may appear attractive at first. But the appeal will wear off.

What the study gets wrong is the timescale. Sometimes aggression and dominance will characterise a strong leader. But company-building is more collaborative than adversarial. Leaders need to co-operate with employees, partners, distributors, customers etc. As a result, executives who optimise for the confrontational aspects of their job, rather than the collaborative ones, will miss the mark. As tempting as it is to use this study as an excuse to become the bad boy of business, I'm convinced the professors have come to the wrong conclusion. Nice guys don't finish last. It just takes a while for the true value of positive, collaborative leadership to shine through.

[1] Nir Halevy et al, forthcoming, "Status conferral in intergroup social dilemma: behavioral antecedents and consequences of prestige and dominance", Journal of Personality and Social Psychology

David Hornik is the author of Ventureblog

ILLUSTRATIONS: PARKOPOLO; ANGUS GREIG; DAVID LEMM

JEREMY RIFKIN_

Energy-sharing is the new internet

The Second Industrial Revolution, powered by oil and other fossil fuels, is spiralling into a dangerous endgame: prices are climbing, unemployment remains high, debt is soaring and the recovery is slowing. Worse, climate change from fossil-fuel-based industrial activity looms. Facing a collapse of the global economy, humanity is desperate for a new vision to take us into the future.

History's great economic revolutions occur when new communication technologies converge with new energy systems. Energy revolutions make possible more expansive and integrated trade. Accompanying communication revolutions manage the new complex commercial activities. In the 18th and 19th centuries, cheap print technology and the introduction of state schools gave rise to a print-literate workforce with the skills to manage the increased commercial activity made possible by coal and steam power, ushering in the First Industrial Revolution. In the 20th century, centralised electricity communication – the telephone, radio and television – became the medium to manage a more complex and dispersed oil, auto and suburban era, and the mass consumer culture of the Second Industrial Revolution.

Today, internet technology and renewable energies are about to merge to create a powerful infrastructure for a Third Industrial Revolution (TIR). In the coming era, hundreds of millions of people will produce their own green energy and share it in an "energy internet", just as we now generate and share information online. The creation of a renewable energy regime, loaded by buildings, partially stored in the form of hydrogen, distributed via an energy internet and connected to plug-in zero-emission transport, establishes a five-pillar infrastructure that will spawn thousands of businesses and millions of sustainable jobs. The democratisation of energy will also bring with it a reordering of human relationships, impacting the way we conduct business, govern society, educate our children and engage in civic life.

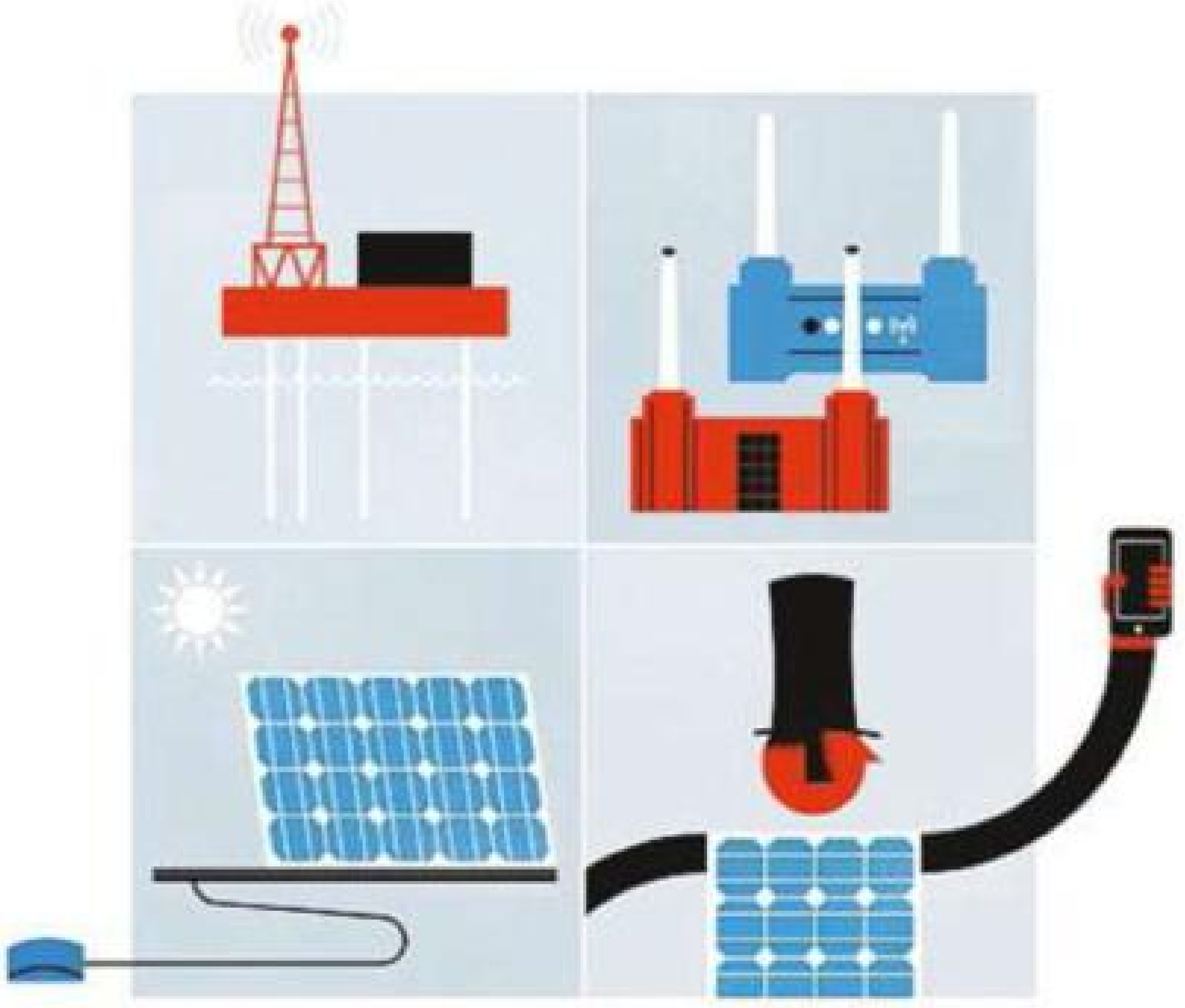
The TIR will lay the foundations for a collaborative age. Its completion will signal the end of a 200-year commercial saga characterised by industrious thinking, entrepreneurial markets and mass workforces, and the beginning of a new era marked by collaborative behaviour, social networks and boutique professional and technical workforces. In the coming half-century, conventional, centralised business operations will be increasingly subsumed by the distributed business practices of the TIR; and the traditional, hierarchical organisation of power will give way to lateral power organised nodally across society.

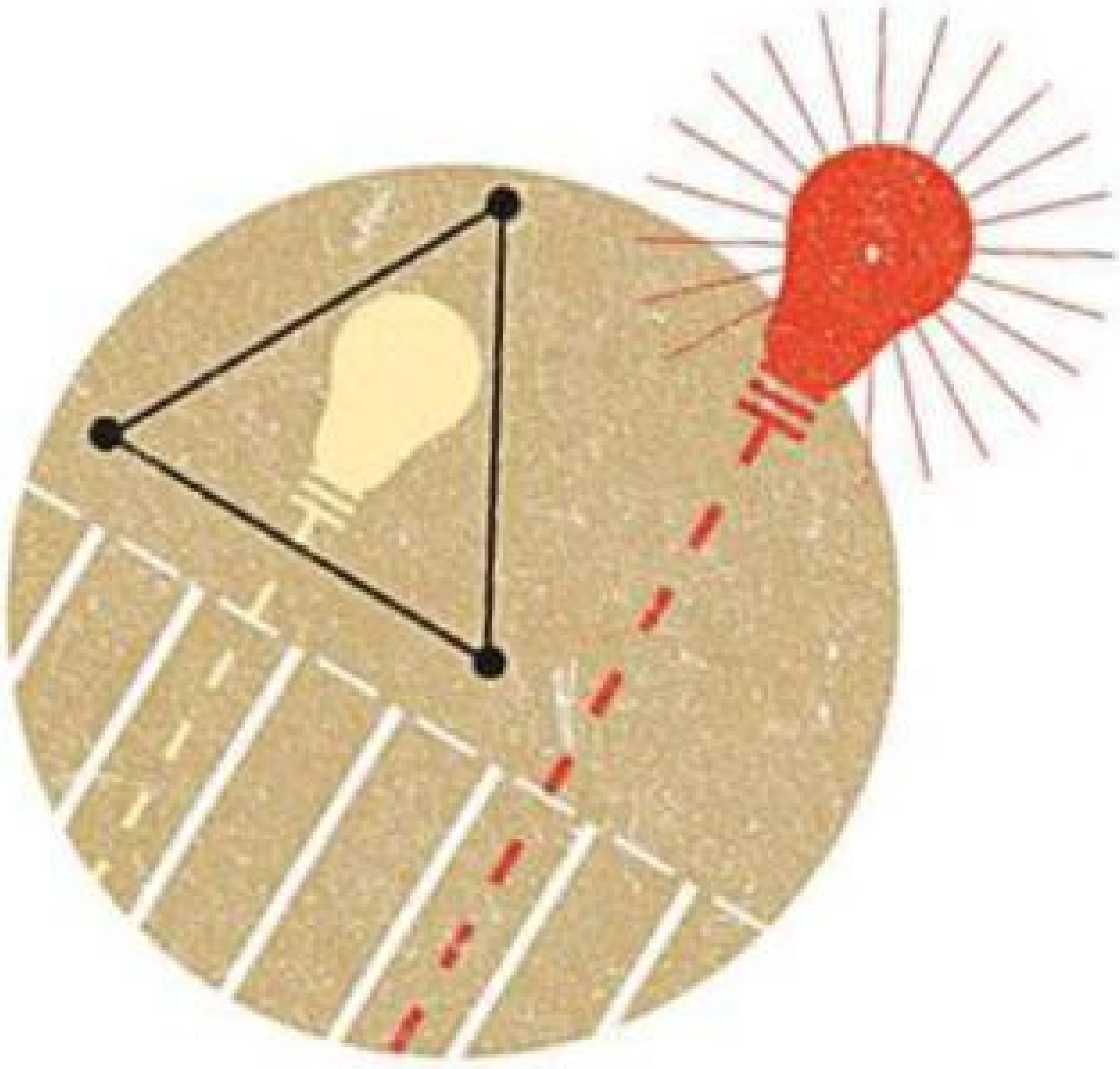
At first glance, lateral power seems a contradiction. Power, after all, has traditionally been organised pyramidically. Today, however, the collaborative power unleashed by internet technology and renewable energies restructures human relationships, from top to bottom to side to side, with profound consequences.

The music companies didn't understand distributed power until millions of people began sharing music online, and corporate revenues tumbled in less than a decade. *Encyclopedia Britannica* did not appreciate the collaborative power that made Wikipedia the leading reference source in the world. Newspapers didn't take the blogosphere seriously; now many titles are either going out of business or moving online. The implications of people sharing energy are even more far-reaching.

To appreciate how economically disruptive the TIR is, consider the changes over the past 20 years. The democratisation of information and communication has altered the nature of global commerce and social relations as significantly as the print revolution. Now, imagine the impact that the democratisation of energy across all of society is likely to have when managed by internet technology.

Jeremy Rifkin is the author of The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World *(Palgrave Macmillan)*





ANIL K GUPTA AND HAIYAN WANG_

Why innovators don't always win

Godfrey Hounsfield, an EMI scientist, conceived the world's first CT scanner in 1967. By the time he won the 1979 Nobel Prize in Medicine, EMI had ceded almost complete control over the CT scanner market to later entrants GE and Siemens. Ed Roberts, designer of the Altair computer, is widely regarded as the inventor of the personal computer. Steve Jobs and Steve Wozniak brought computing to the masses in 1977 but it was a later entrant, IBM, that first dominated.

These and countless other examples illustrate a harsh reality. Often, it's not the innovating firm that emerges as the market leader. Steve Jobs 1.0 was blind to this common reality. Jobs 2.0 was shrewder. During his exile from Apple, he had learned that he must also translate great innovations into market leadership.

Why do innovators not always win (and why do they sometimes)? There are three reasons.

Inability to protect IP rights is the most obvious reason why innovators lose out. Schneider Electric, a French firm, learned this lesson when it faced a lawsuit brought by Chint, a Chinese firm. Schneider's argument that Chint was a copycat proved futile in Chinese courts. Schneider was forced to pay damages and cede the market for that product to its nemesis.

A second reason is devotion to technology instead of usability and customer benefits. This is why Apple's first PDA, the Newton, was a dud. Instead of resting on their laurels, innovators need to spend time and effort to look at the product from the customer's point of view. Customers care about ease of use and benefits, not innovation per se.

The third reason is blindness to the importance of complements. EMI's leadership in CT was by itself insufficient. It needed a manufacturing, sales and service network – which GE and Siemens dominated. The 1984 Mac could not by itself win market leadership. Computers are useless without software, a domain where the IBM-Microsoft-Intel team was ahead of Apple. Too many innovators overlook the role of complements in enabling firms to win the hearts, minds and wallets of the end customers.

Barack Obama too made this mistake. He has called on the US to outinnovate other countries. What he overlooks is that the US's problems have little to do with R&D. Instead, the problems lie in a complement to R&D – a manufacturing sector that is much weaker than it was in 1990.

Anil K Gupta is a professor at the University of Maryland and Insead. Haiyan Wang is managing partner of the China India Institute. They are the authors of Getting China and India Right *(Wiley) and* The Quest for Global Dominance *(Wiley)*

DAVID WOLMAN_

A universal currency could end the crisis

Despite all the evidence that it could never work (we're looking at you, euro zone), the idea of a universal currency just won't die. Thanks to the debt crisis, some Greek officials are contemplating dumping the common currency for the drachma. Meanwhile, Italy and Spain teeter. A decade after the shared currency was heralded as a 21st-century tool for peace and prosperity, it turns out that currency unions aren't such a hot idea.

Not so fast, though. This is undeniably a period of epic turmoil, and many economists will tell you that sovereign states need sovereign currencies – full stop. But this notion ignores a fundamental truth: countries with their own currency may have monetary independence, but in reality – as gun battles in Libya, collateralised debt obligations in the US, and tsunamis in Japan have taught us – we are only becoming more economically intertwined, regardless of what our coins look like.

Step back from the current crisis to consider the long view, and currency unions – or even a single global currency – have a fair share of appeal. A universal medium of exchange could eliminate currency risk and jack up trade. It would mean speculators couldn't short an individual country's currency. Exporters wouldn't have to fret over the gap between a price on a contract and the value of the payment. A single currency could halt spastic swings in prices and end conversion fees, leaving more of the pie for little stuff such as R&D and employee health insurance. Oh – and it could put an end to international disputes over currency manipulation. Hello? China?

True, sovereign currencies afford the ability to manipulate the money supply, jiggle the handle of interest rates, and buy up piles of toxic assets. When a boom goes bust, devaluing currency is the least bad way for governments to rein in wages and prices that are suddenly too high. But if you use the same currency as another country that isn't in dire straits, good luck convincing them to accept devaluation.

But does this mean we'll never see a global currency? A recent Pew Research poll reveals that 41 per cent of Americans expect it by 2050. Maybe the idea has been planted in our heads by leftist utopians and science fiction authors: "credits" are used in everything from *Star Wars* to *Star Trek*. Yet economics titans such as John Maynard Keynes have also touted the idea.

The fact is, the modern economy and monetary system are too precarious for us not to examine every possible way to protect against future shocks. It's a bit like geo-engineering: radical and outrageous at first blush but, given humanity's current predicament, not as outrageous as dismissing it.

Some pundits insist that gold could do the trick or that we could achieve many of the benefits of a global currency by tying the value of national ones to a set amount of the shiny stuff. But most economists view a return to gold as anachronistic, absurd and even hazardous. Maybe, but it's possible they're saying so because reviving the gold standard is so incongruous with the present and not necessarily because it would result in a system inferior to today's.

Of course, the universal currency could be the US dollar, and in some ways that's already the case. The greenback is what central banks hold the most of on reserve, and it's the currency used for the vast majority of international transactions. But the dollar's special status seems less stable than ever – and will worsen if Washington can't deal with the debt. Perhaps the seed for that universal currency has already been planted. The International Monetary Fund uses something called Special Drawing Rights, a crossbreed of four of the world's key currencies, to make certain kinds of settlements between IMF members. Could SDR someday morph into the One Coin to Rule Them All?

A global currency may indeed prove to be a vision best left in the realm of fantasy. But it would behoove us to seriously analyse the pros and cons before ditching the idea in favour of today's smorgasbord of euros, pesos, yuan and Malawi kwacha.

David Wolman is the author of The End of Money (Da Capo Press), out in March

ILLUSTRATION: SAM FALCONER

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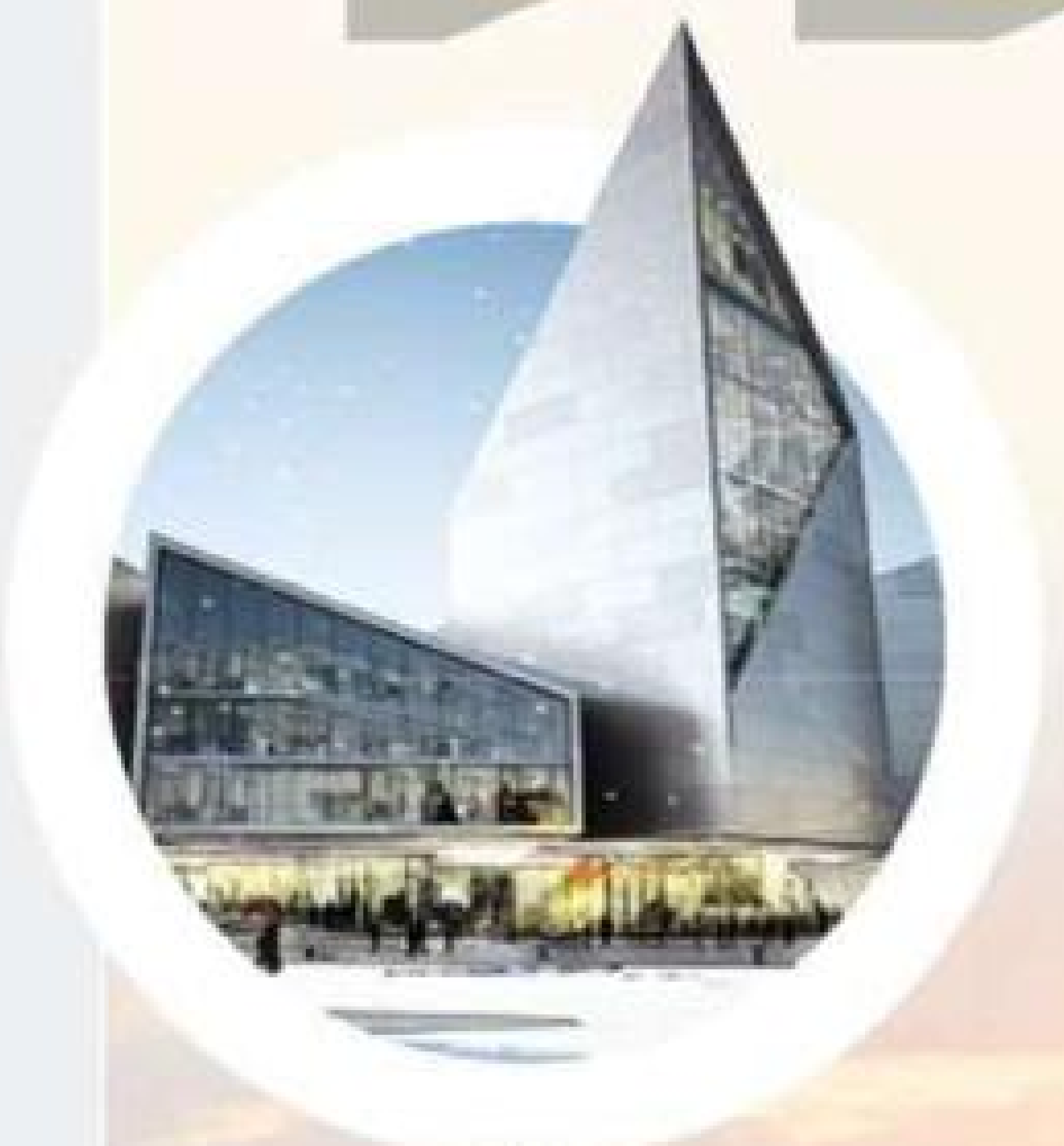
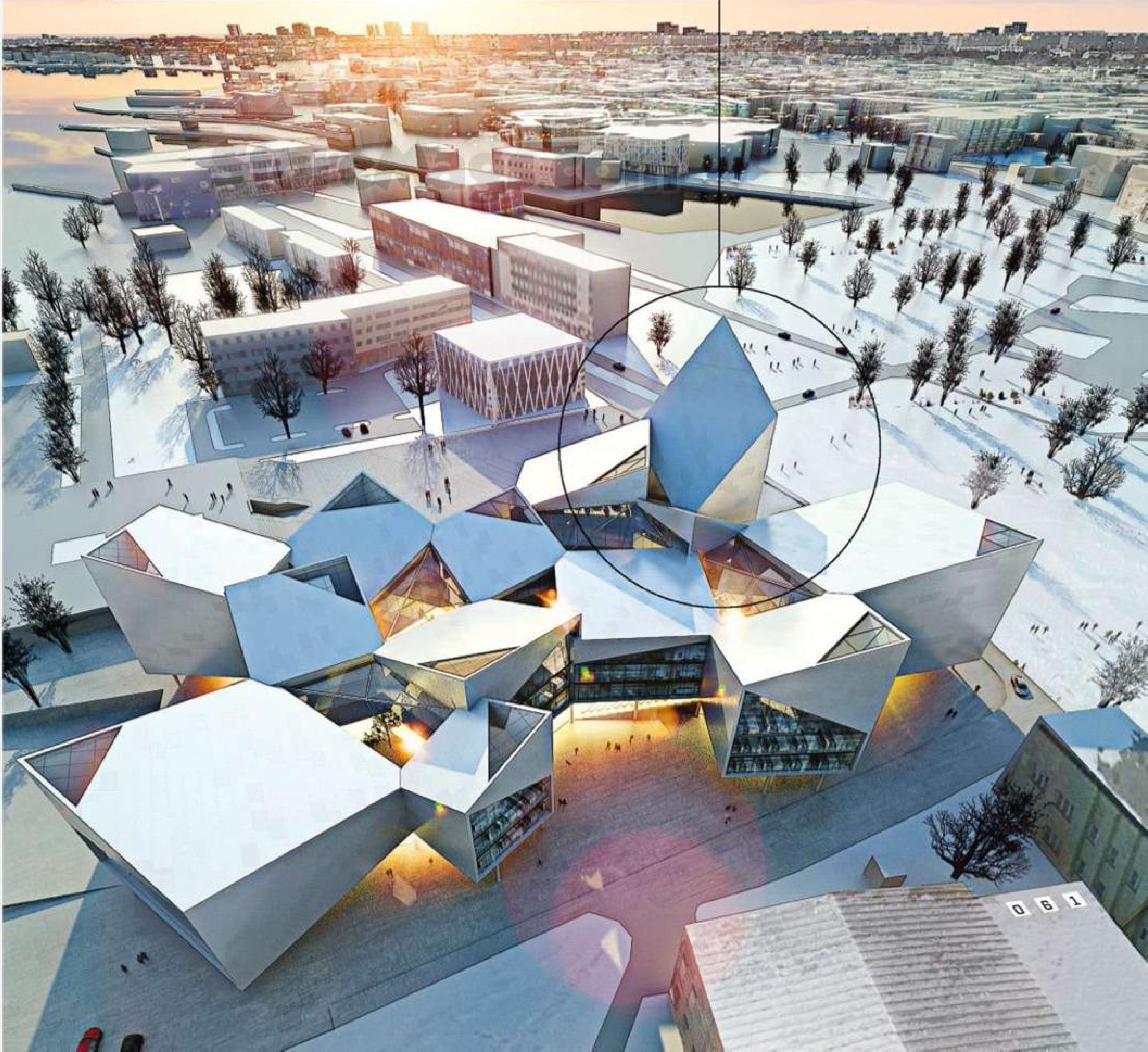


TWO-WAY TOWN HALL

Bjarke Ingels's latest building, the new Tallinn town hall, will allow Estonians to check that its officials are busy running the city, and not playing *Angry Birds.* "The idea is transparency – so people can see democracy at work," says the 37-year-old Danish architect (see WIRED 07.11). "We thought that if we made the ceiling of the council chamber a gigantic mirror, it would reflect the landscape – a live portrait of the city that they're messing with." And anyone standing in the square outside can see directly into the council chamber through what Ingels calls a "democratic periscope". "They'll be able to see if council members are absent," he adds. "And, in theory, see what notes are being scribbled down or what dirty deals are being plotted."

The project, from Ingels's Copenhagen- and New York-based architectural practice BIG, will break ground in the spring. Ingels says that Estonia's politicians are surprisingly comfortable with being scrutinised. "They like the idea of radical political transparency," he says. "But when we explained the project to the president's office in Kazakhstan [where BIG has designed a new national library], they said it would have cost us the job." **TC** *big.dk*



Style by numbers

Dressipi uses probability data to predict your taste

Amazon doesn't recommend a book based on where you read it. Last.fm can't scrobble what mood you're in. But Dressipi aims to do exactly these for fashionistas. Cofounders Sarah McVittie and Donna Kelly have created a context-aware recommendation engine that picks clothes to suit its users' tastes, based on occasion or mood – an algorithm that knows that you might love a pair of jeans, but not for next week's wedding. "Sarah and I have very different ideas of glamour," says Kelly, 42. "Understanding context and how that maps to someone's personality is key."

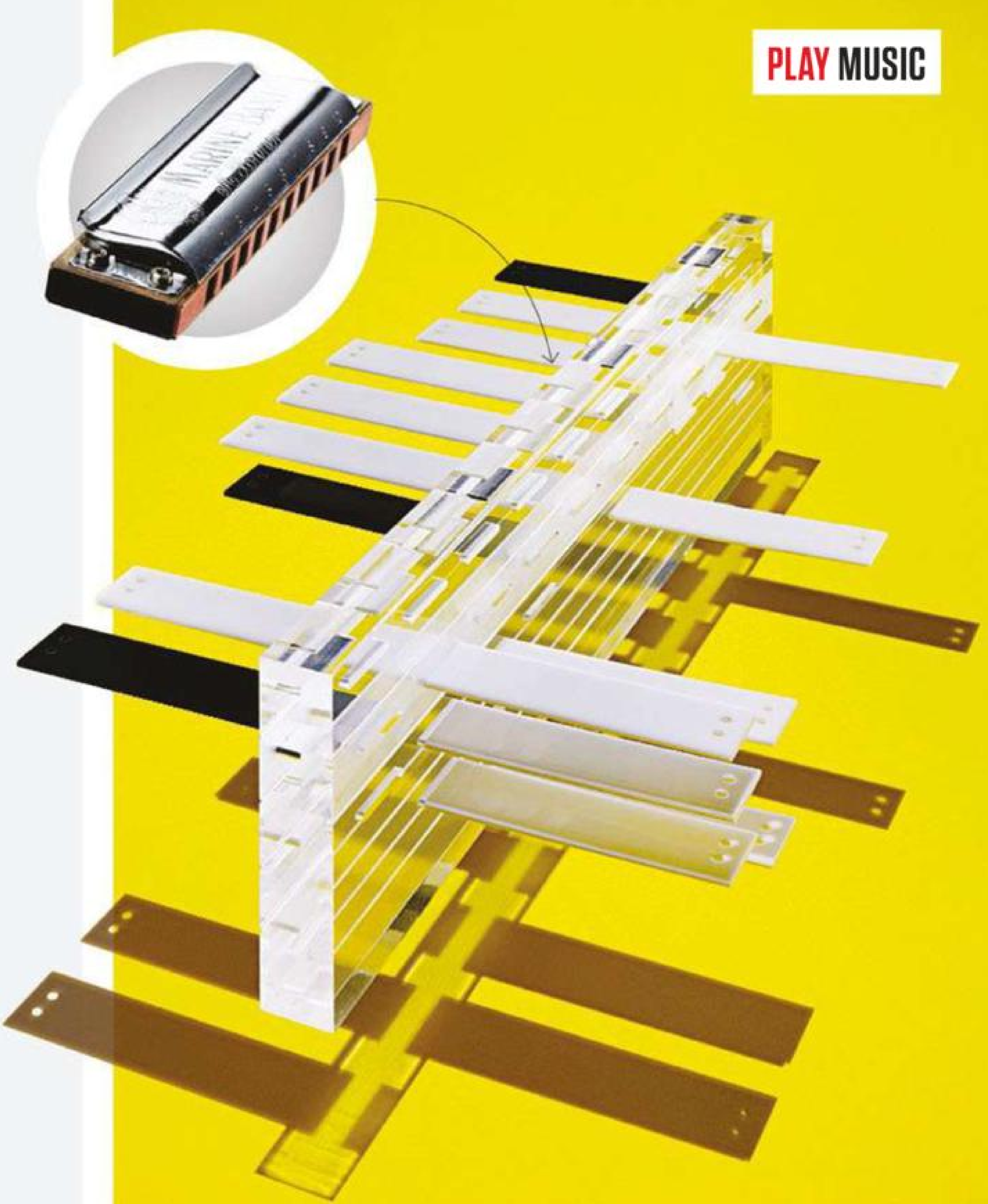
To find out a user's "fashion fingerprint", Dressipi first determines their shape – not by measurements, but by asking them for details of four favourite items sitting in their wardrobe. Hundreds of features such as neckline and skirt length are identified automatically in each garment. The features are then combined and fed through a set of rules devised by Dressipi's six stylists to build up a probabilistic model of what a user will like, shown as a points score. "We're on our fifth iteration of style, and it's currently around 80 to 85 per cent accurate," says McVittie, 34.

The site came out of beta in November and attracted 20,000 users by the end of its first week. And the west

PHOTOGRAPHY: NICK WILSON; SUN LEE

London-based company is, at the time of writing, about to launch an iPhone app, so "you can have a portable fashion fingerprint," says North. "The aim is, you walk into a retailer, scan a barcode and the app tells you the dress will go well with that jacket you bought two weeks ago." The millions of data points that Dressipi collates could offer "a far better experience" than human stylists. The machines may or may not take over the world, but they will ensure we're impeccably dressed. **TC** *dressipi.com*

1. Donna Kelly
2. Selina Mills
3. Tara Kavanagh-Dowsett
4. Elena Duranova
5. Sarah McVitie
6. Natalie Theo

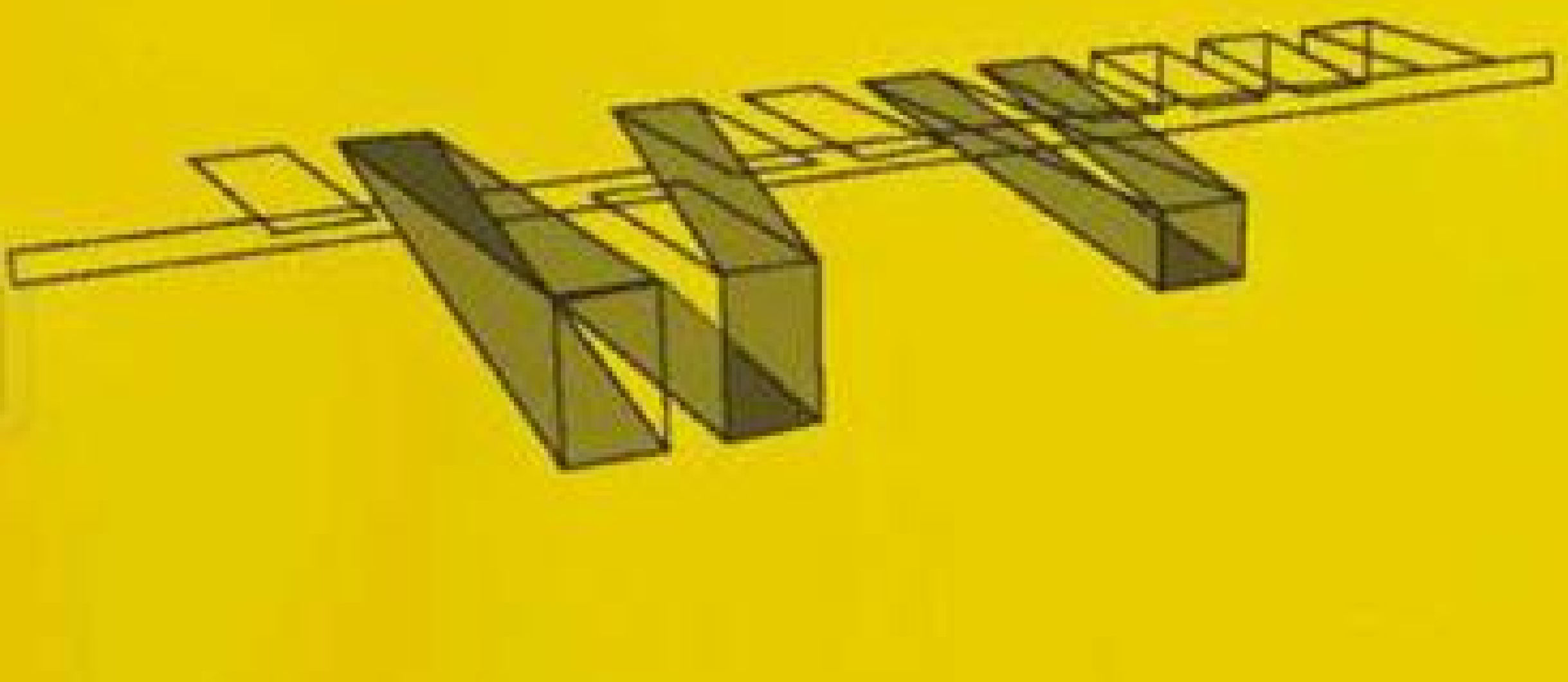


MUSICAL TALENT: IT'S A STATE OF MIND

Want to improve your musicianship? It's all in your head, claims harmonicist Lee Sankey. For his forthcoming book *Brainstruments,* Sankey interviewed neuroscientists such as Chris Frith and Peter Vuust, along with nearly 50 professional musicians. His conclusion: your mind is the instrument.

"Our experience of the world is a mental model constructed by our brains based on inputs from our senses," says the 41-year-old. "When you're playing an instrument, you're playing the brain's mental model of it."

Sankey found that 90 per cent of the professional musicians he talked to constructed a spatial and directional mental model (his own, of playing the harmonica, is shown above). Just a third of amateurs did the same. So, if you want to become a better musician, think about playing. "The clearer your mental model," says Sankey, "the better you'll play." TC



Left and above: When playing the harmonica, Sankey pictures a series of "spatial arrangements"

Back to the electric 80s

The DeLorean EV is bringing retro cool to tomorrow's cars

History does not record John DeLorean as a visionary automotive engineer. Instead, he's remembered as the man who took the British government for the equivalent of £250 million, when his Belfast-based company went bust in 1982.

But his original vision for an "ethical sports car" may now be coming true. The DeLorean EV (electric vehicle) is a zero-emission update that keeps the original design intact. This latest reincarnation is down to Texas-based Brit Stephen Wynne, 55, who swept up the remnants of the operation in the late 80s, and has been restoring DeLoreans since. "It was getting so elaborate, I just took it apart and rebuilt it."

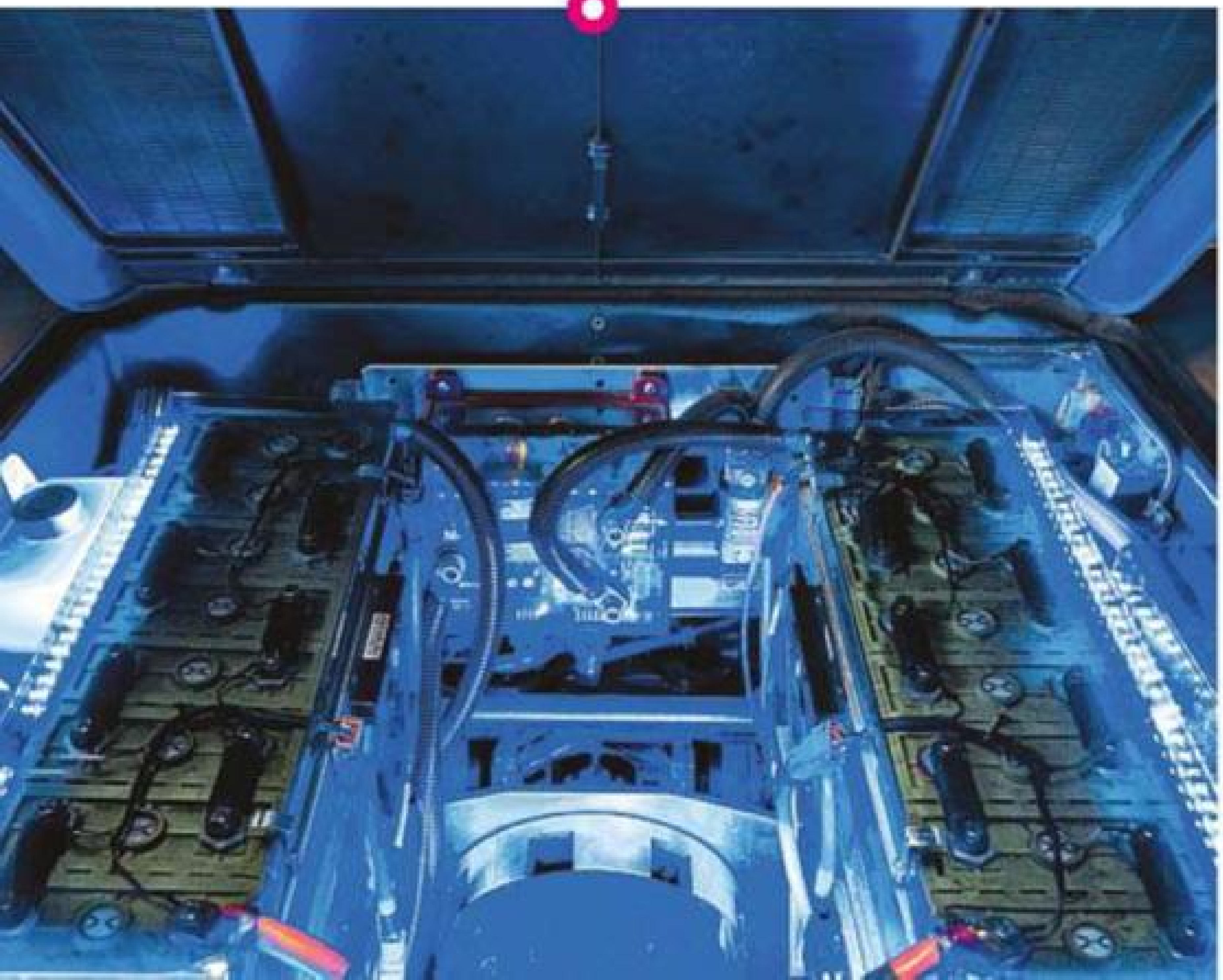
The EV version, says Wynne, was a natural evolution. The car uses lithium ion phosphate batteries, arranged throughout the vehicle to improve the original weight distribution, and its total power output is 32kWh, giving it a range of up to 150km on a full charge. "The car weighs about 1,400kg," says Wynne, "but we're aiming to shave off some of the weight."

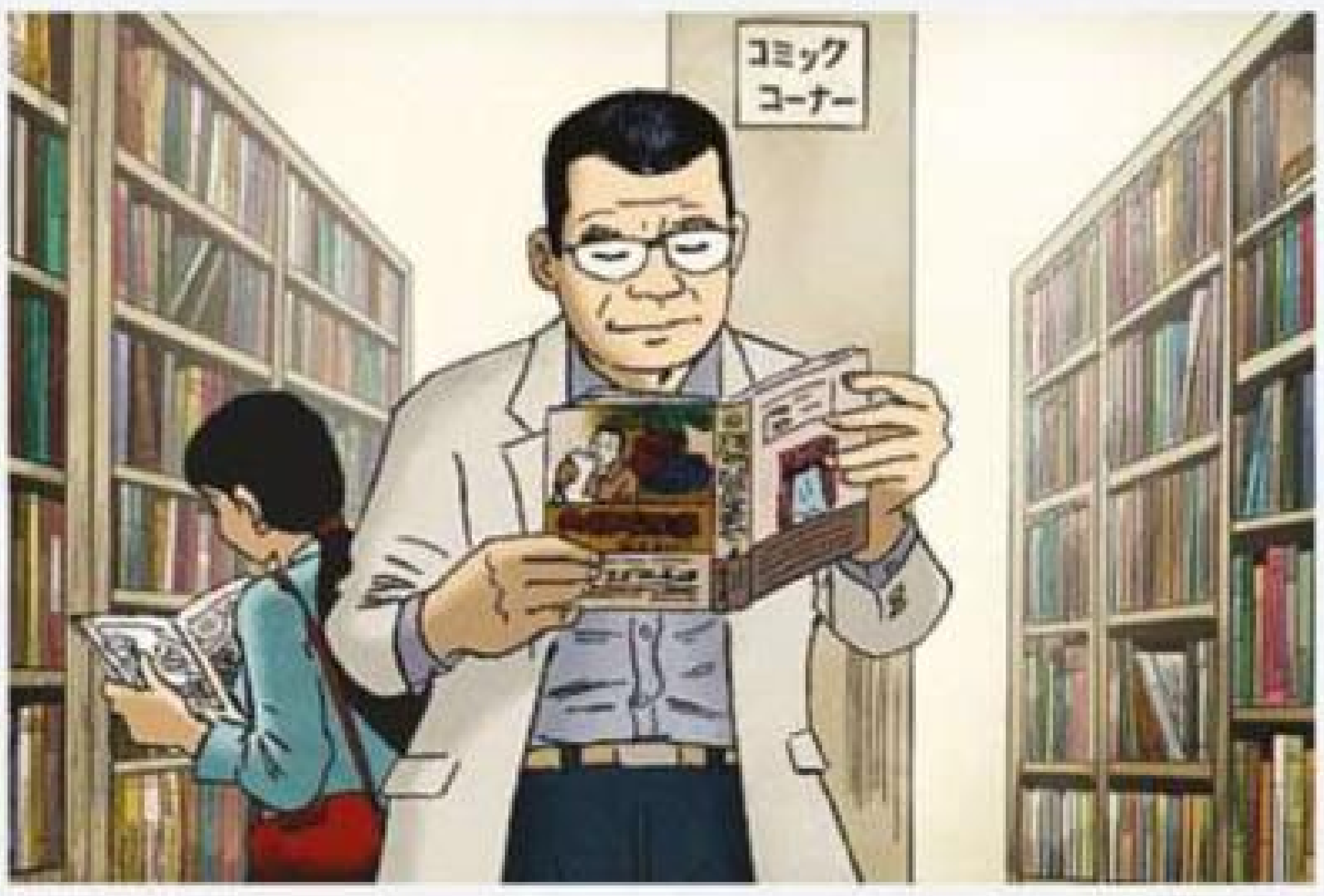
Tesla's EVs showed that green cars could also be sporty (WIRED 11.10), but Wynne is unfazed by his established, high-profile competitor. "I hear Elon Musk say, 'We're not another DeLorean.' And I think, 'You better watch your mouth, buddy – there are still more DeLoreans on the road than Teslas.'"
Jason Barlow *delorean.com*

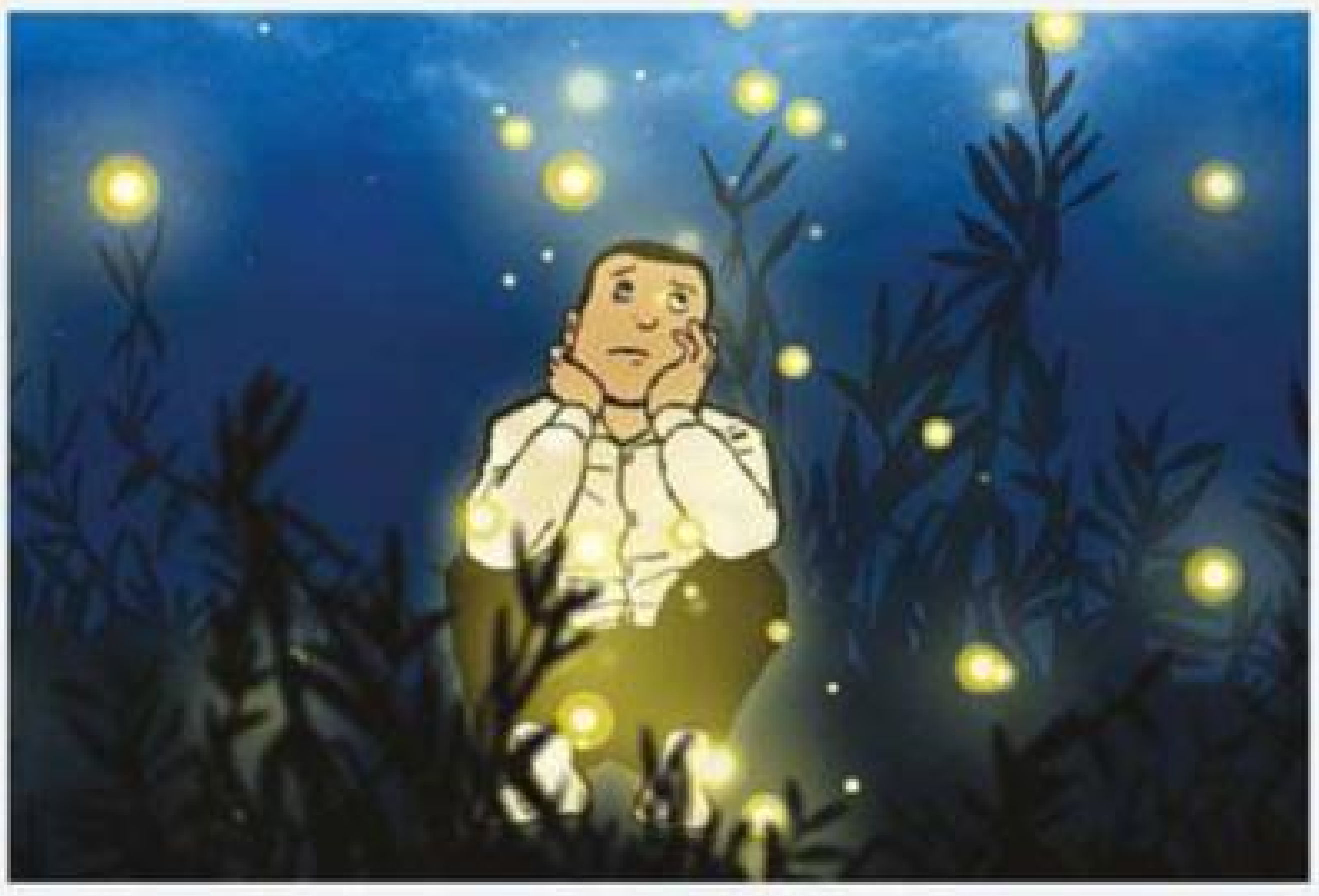
▸ The DeLorean EV keeps the iconic gull-wing doors and brushed metal body...

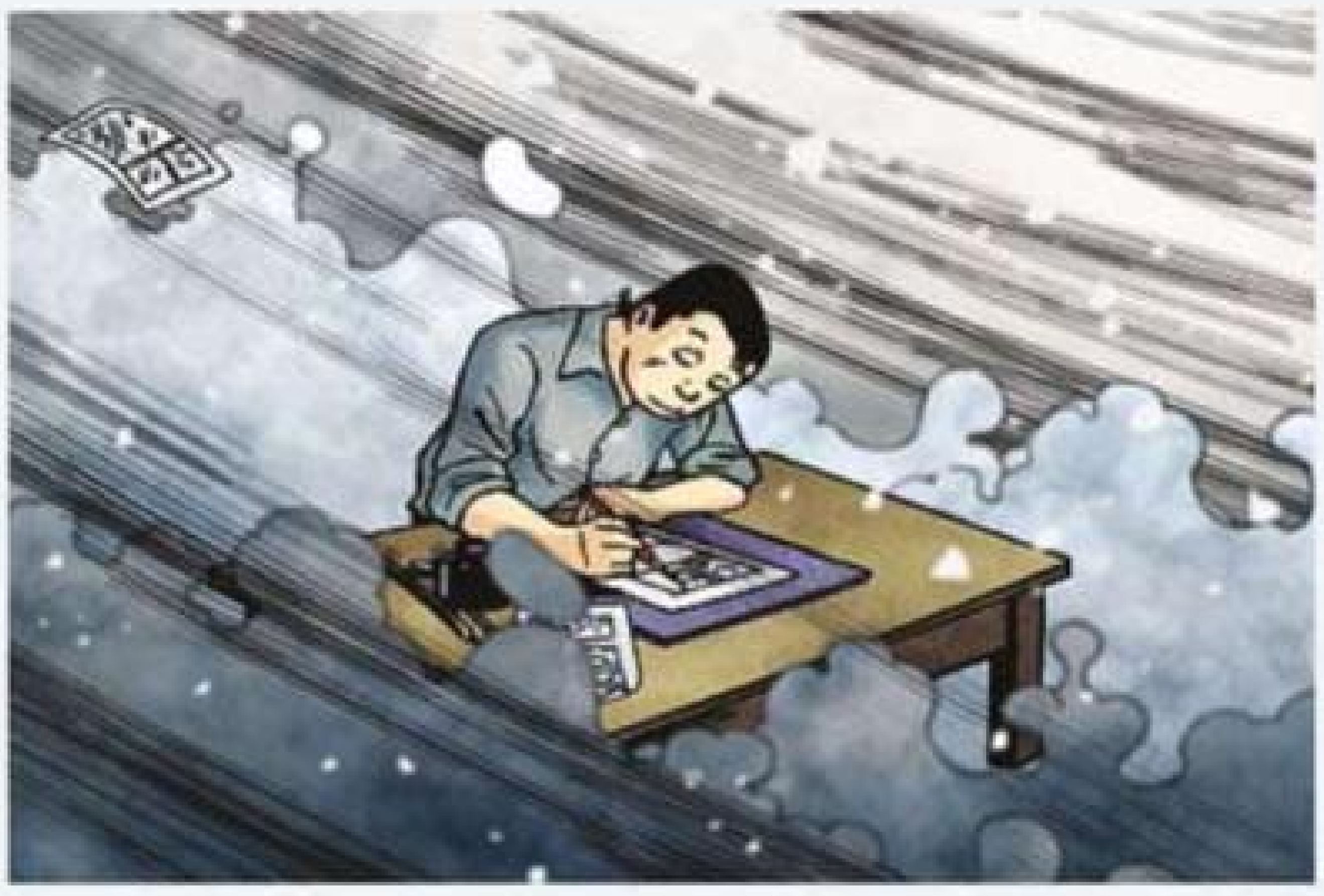
▸ ...But it uses lithium ion phosphate batteries, so no lightning strike is required

PHOTOGRAPHY: MATTHEW MAHON









A CONTRACT WITH TATSUMI

In 1978, Will Eisner popularised the graphic novel with *A Contract with God* and showed comics weren't just for kids. Twenty-one years earlier, Yoshihiro Tatsumi did the same for manga, coining the term "gekiga" – Japanese for "dramatic pictures" (manga means "humorous pictures").

"It was a counterculture," explains Singaporean director Eric Khoo, who has turned Tatsumi's own life into an animated gekiga for the big screen, narrated by the author. "Young students were reading this material, but whenever a crime was committed, newspapers would say it was because of gekiga corrupting the youth." Perhaps with good reason: prostitution, murder, dismemberment and incest feature in the five stories contained in Khoo's *Tatsumi*.

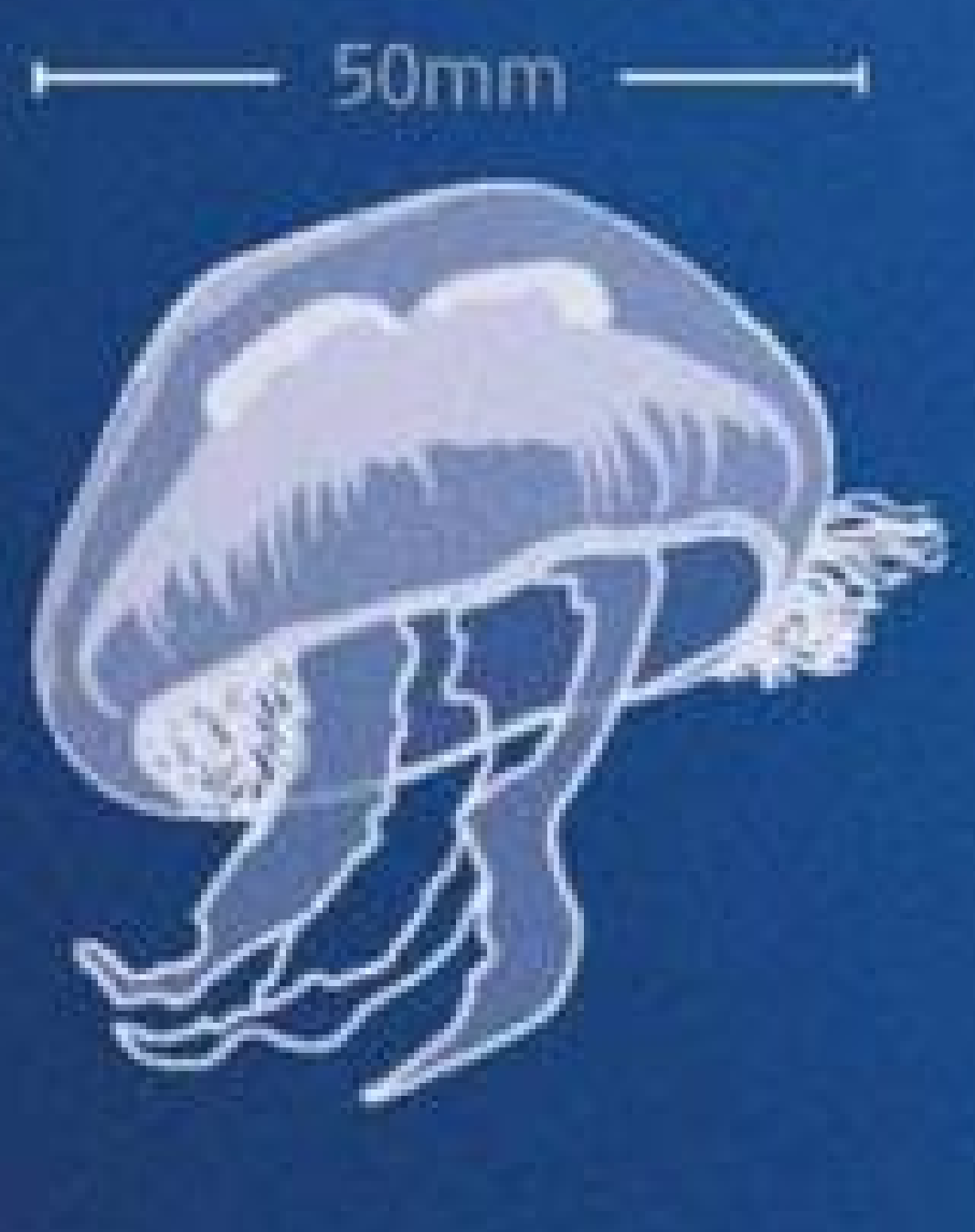
"A lot of what Tatsumi experienced as a child, growing up with American troops in Japan, gave him ideas," says Khoo. "As a young boy, the GIs would give him a balloon and he would be blowing it up, then his mother would scold him – it would be a used condom. We can look back at his work and say it was perverted, dark, but there was a great sense of humanity, too." TC *Tatsumi is released on January 13*

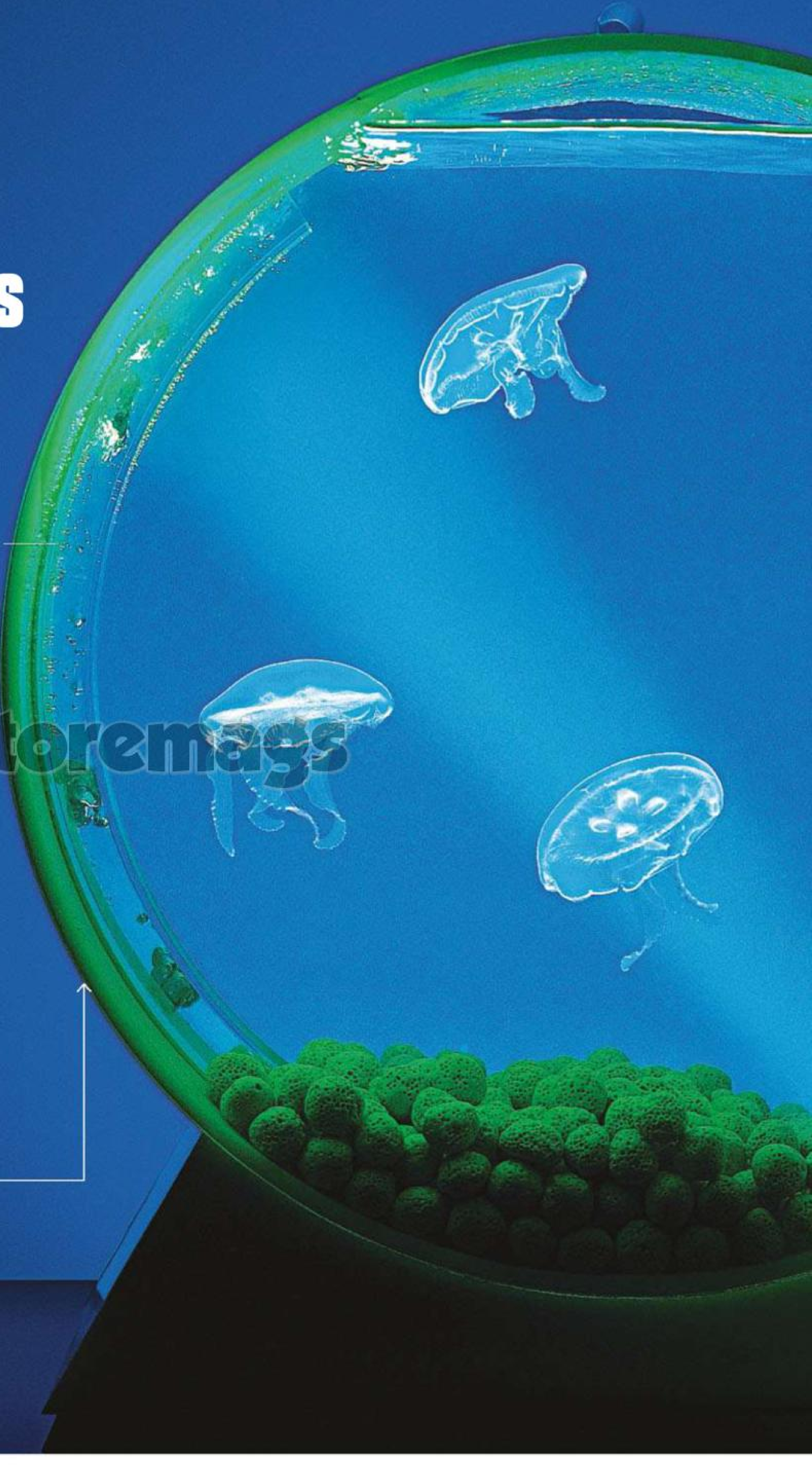
Stockmags

Surreal swimmers

Goldfish are gauche – unwind your mind with the ultimate exotic pet

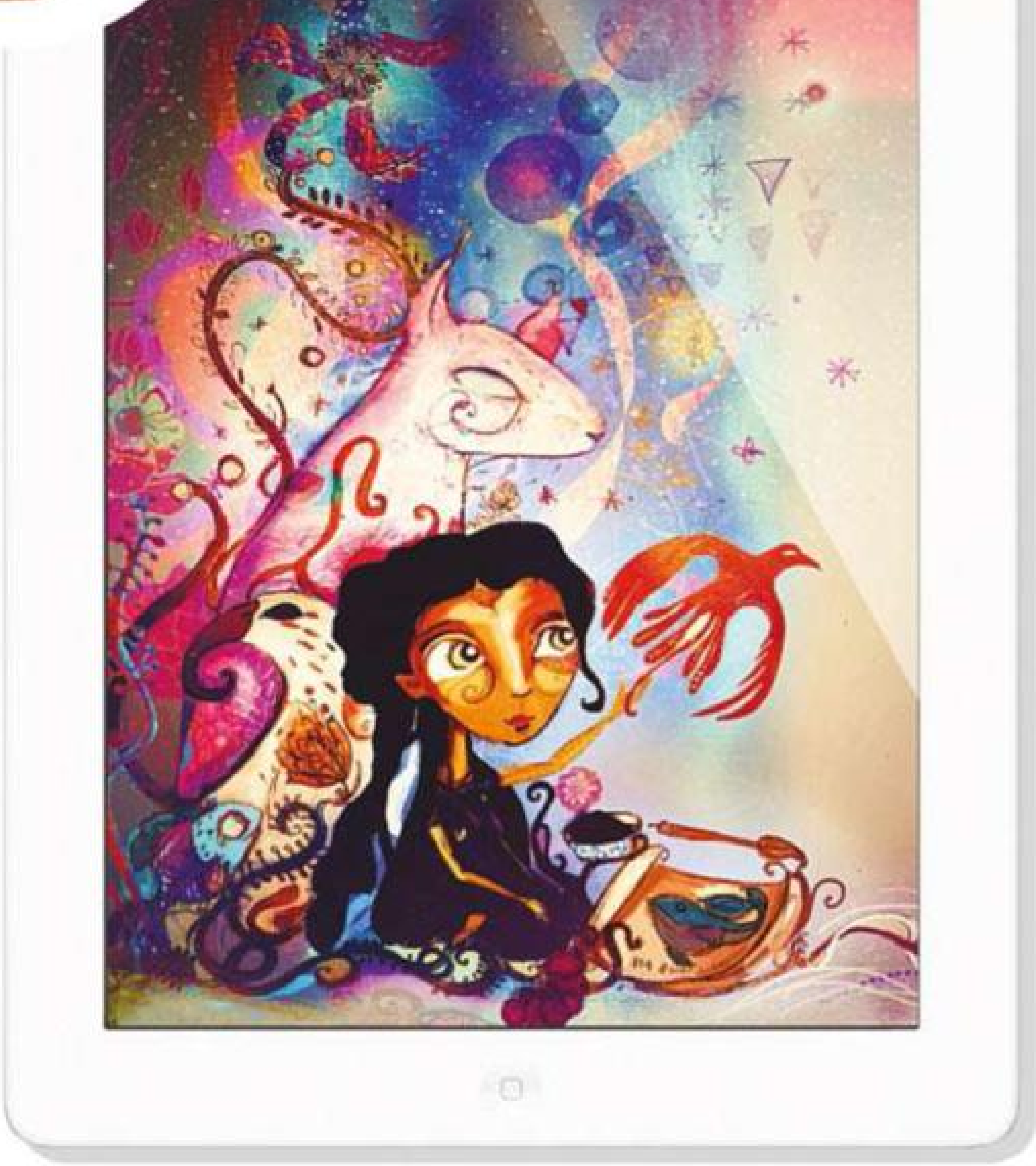
Jellyfish used to get a raw deal in home aquaria: the blobby beasties tend to get shredded by water filters. But this 25-litre tank, designed by San Francisco-based Alex Andon, has jellyfish safety at its heart – a laminar-flow system circulates the water in a controlled swirl, nudging the jellies to the middle of the tank and away from danger. Andon funded his project through Kickstarter, and the finished product costs $460 (£300). He supplies US customers with mail-order Moon jellyfish for $39 each, shipped in Styrofoam coolers; a six-month food supply of frozen brine shrimp is $54. Drop the jellies in, turn on the colour-changing LED light, and relax... **Josie Garthwaite** *jellyfishart.com*





The tank is on Kickstarter's most-funded list, with more than $100,000 of investment

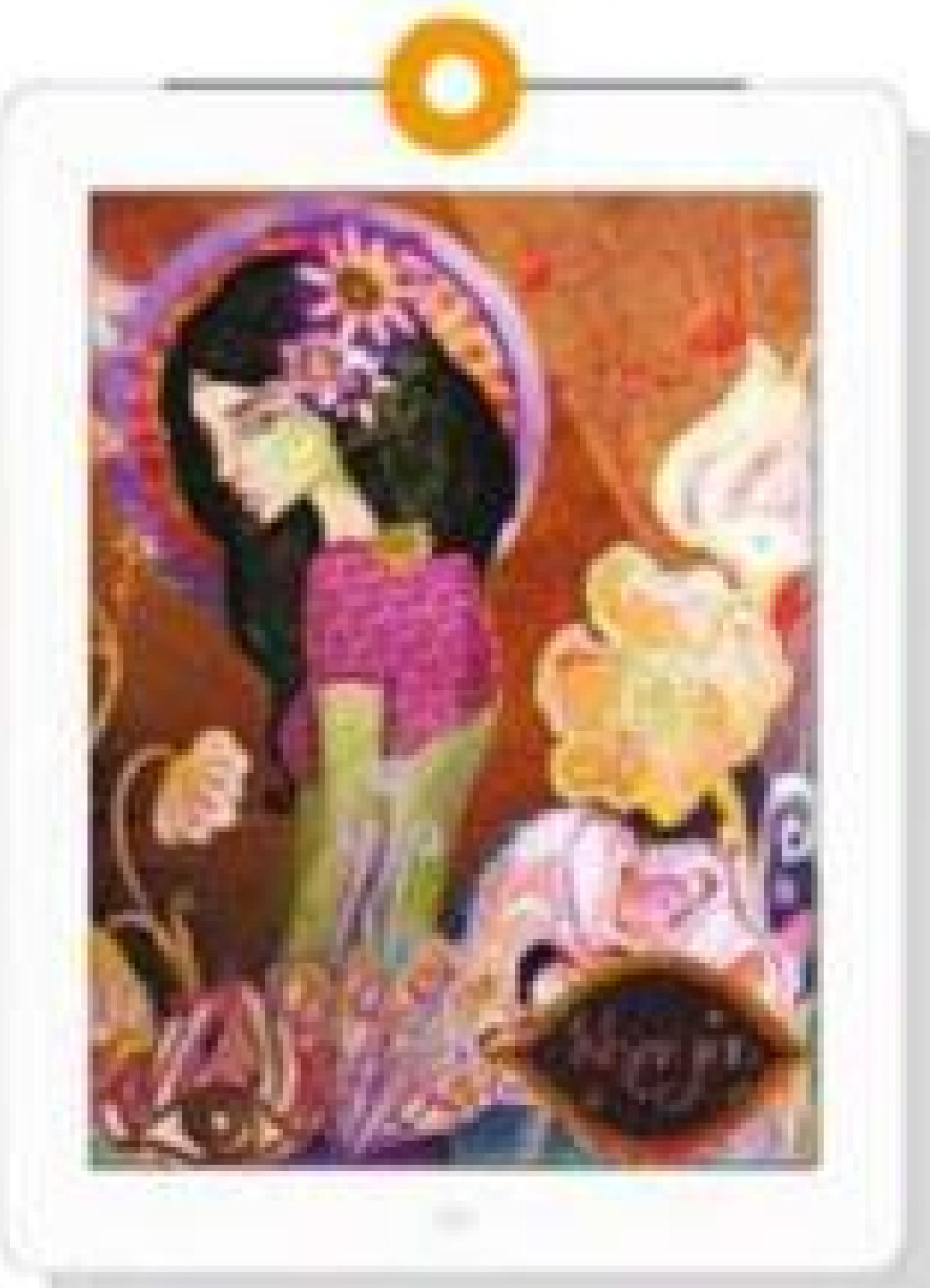
PHOTOGRAPHY: GREG BROOM



SCREEN LEGEND

The Sanskrit poem Mahabharata depicts the warrior Arjuna firing arrows into the Earth to produce water. "Nothing's changed – now we do the same with drills and machines," says illustrator Shilo Shiv Suleman (above), a speaker at WIRED2011. "We replaced magic with machinery." So Suleman, who's based in Bangalore, decided to create a new epic that would combine the two – using the iPad.

Khoya is the first interactive book in an eight-part series that mixes a traditional Indian aesthetic with modern storytelling. For instance, augmented reality shows "apsaras" (the Indian equivalent of nymphs) dancing in the trees of a garden. "Epic stories such as the Mahabharata and Ramayana have been told in different styles," says Suleman, 22. "But it's exciting to create one's own mythology from the old archetypes to deal with new issues." TC *bonifisheii.blogspot.com*



- In *Khoya*, a girl and boy reconstruct a spirit world using their imagination
- In the second book, the children meet apsaras in the Valley of Flowers
- The reader uses this compass to navigate through the multiple worlds of the app

Mixing chat and choons

Turntable.fm's Billy Chasen hosts Silicon Valley's A-list at his virtual nightclub

Billy Chasen wants to fix the way we listen to music. "When people started using iPods and just kind of plugging in, we lost the social aspect of listening to music," says the cofounder and CEO of Turntable.fm. Turntable works as a virtual party – up to 200 users, represented by avatars, can occupy each themed room. A designated user acts as DJ, spinning records from the Turntable library or a personal iTunes account. Everyone else can listen in and vote tracks "awesome" or "lame"; too many lame votes will kick the DJ off to let another user take over. All the time, users chew the fat on an instant-messenger service.

The real value of Turntable lies in finding new music: the social network doesn't have Spotify in its sights, but algorithm-driven music-recommendation services such as Pandora and Last.fm. "It's powered by people," says 31-year-old Chasen, "so the level of discovery is much higher. And the chat room becomes a place where people just hang out." Recent visitors include Mark Zuckerberg, LCD Soundsystem and Sir Mix-a-Lot. Independently organised Turntable parties are taking the concept into the real world too, with DJs scored according to the number of people on the dancefloor.

Chasen came up with the idea for Turntable two years ago, while sitting in the car with his sister. "We were going back and forth with our iPhones, swapping songs," he says. "I realised there was nothing that could do the same thing online." Turntable launched in June 2011 and now has 700,000 members; its backers include music-industry players such as Troy Carter (Lady Gaga's manager) and The Roots – "but not Kanye West. That's just a rumour," says Chasen. Music-industry love should help bring Turntable to an international audience: the site was initially available worldwide, but quickly restricted itself to the US, to avoid running into conflict with record labels. Chasen says his company is having "active conversations" with European rights holders to bring it here "as soon as we can. The reception so far has been overwhelmingly positive – everybody loves the idea." **TC** *turntable.fm*

Turntable.fm CEO Billy Chasen wants to make listening to music at home more sociable

CELEBRITY SPINNERS

Fancy swapping songs with the A-listers? Turntable has attracted a score of famous names and is even creating its own roster of famous DJs.

MARK ZUCKERBERG

The Zuck sometimes hangs out in the coding soundtrack room: he liked Turntable so much he invited Chasen to speak at the Facebook developers' conference, f8.

DENNIS CROWLEY

The Foursquare founder was one of the early adopters, tweeting: "Okay, totally in love with http://turntable.fm after just 5 minutes. Nice work guys!"

SIR MIX-A-LOT

The veteran rapper performed a live DJ set on Turntable in late June, with a specially created avatar featuring his trademark wide-brimmed hat.

PHOTOGRAPHY: TIMMO SCHREIBER. ILLUSTRATION: BRIAN WALLINE

AND THE AWARD FOR BEST TECH GOES TO...

The technology behind some of cinema's greatest images has its own version of the Oscars, held in February. Here are three hot contenders for a golden statue this year. Matt Hussey ***oscars.org***

REALD CINEMA

If you've seen a 3D film in the cinema, chances are you've used the technology created by RealD. Its glasses use circular polarised light, as opposed to linear polarised, to afford cinema-goers the luxury of being able to tilt their heads without distorting the image on screen.

PICTORVISION ECLIPSE

For those epic shots of city skylines, you need a helicopter. But as the rotors create vibrations, pictures come out blurry. Pictorvision has a super-stable camera system that not only cancels out vibrations, but stays in check with the horizon, even as the chopper changes direction.

MOVA CONTOUR

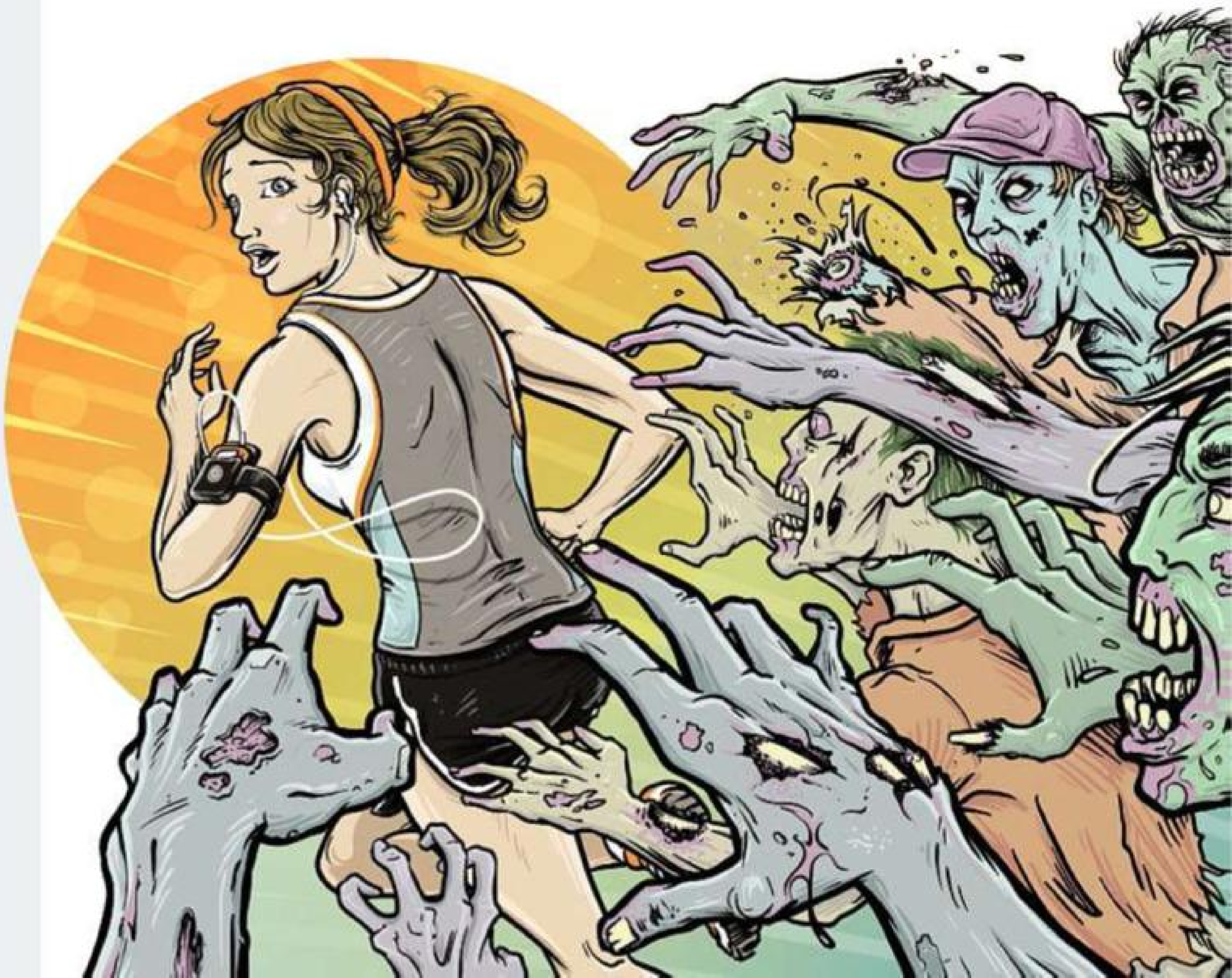
David Fincher used Contour in *The Curious Case of Benjamin Button* to show what Brad Pitt might look like in 30 years. Phosphorescent dye is applied to areas on an actor's face, which special cameras read to map over 100,000 points. A detailed 3D model then creates mind-blowing CGI.

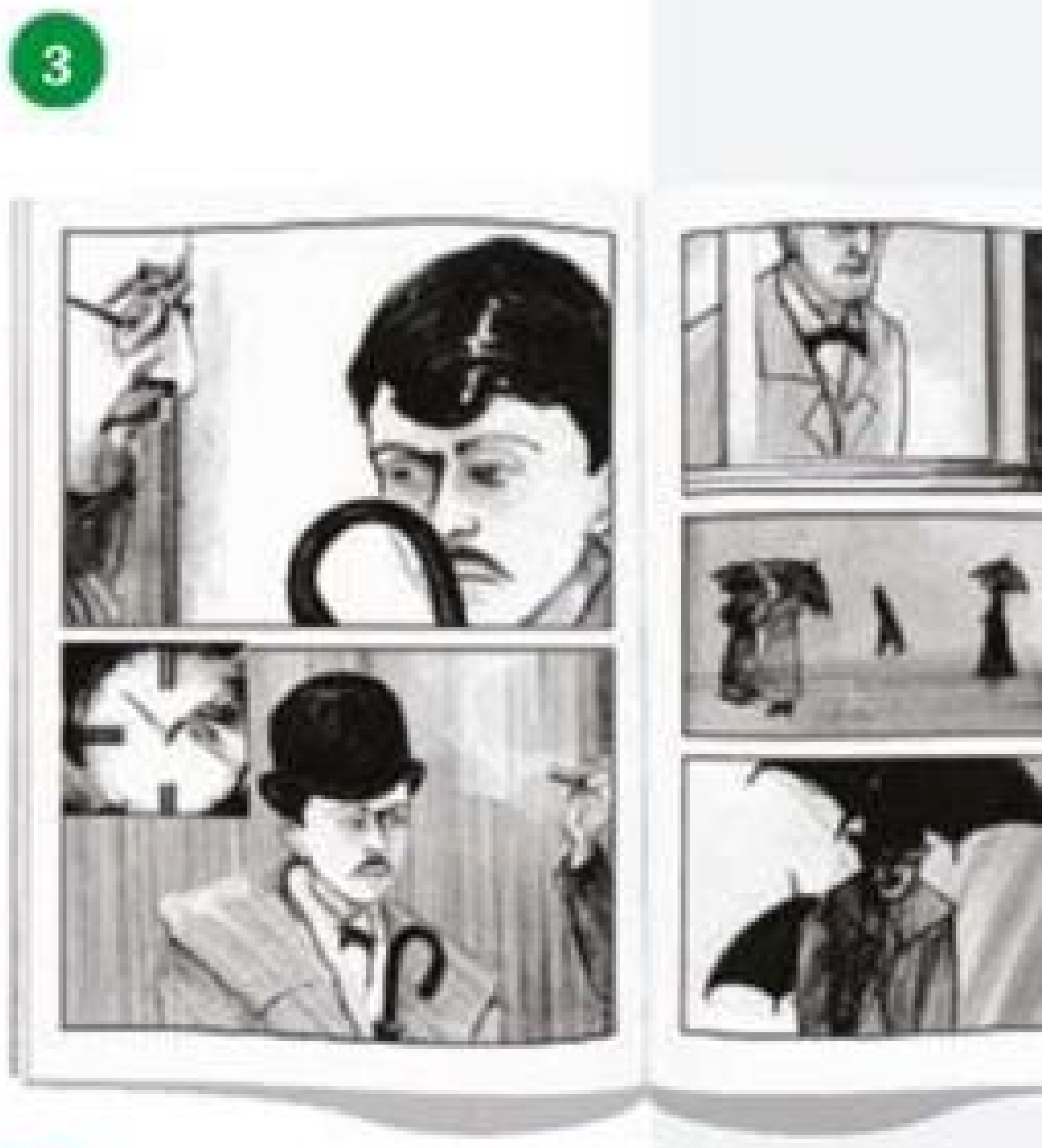
ON YOUR MARKS, GET SET, BRAAAIIINNNS...

When it comes to getting fit, a personal trainer is usually the expert of choice – not an award-winning novelist. But Londoner Naomi Alderman, 37, author of *Disobedience* and *The Lessons*, is the secret weapon behind developer Six to Start's phone fitness app *Zombies, Run!*. "I think this is the best story-driven zombie fitness game in the world," says Alderman of the project. "But then, I think it's the only story-driven zombie fitness game in the world."

***Zombies, Run!* uses narrative to keep backsliders pounding the pavement. Players slip into the trainers of Runner 5, a post-apocalyptic scavenger. As they run, their playlist is interrupted by messages from other survivors, congratulating them for finding supplies or warning of approaching zombies. The moaning of the undead in their earphones means it's time to pick up the pace.**

The first "season" contains 24 episodes, along with plot-free, replayable "grind" sessions and a sofa-to-5K primer. With a mix of plot-driven episodes and monster-of-the-week one-offs, the first season promises aerobic thrills and zombie kills aplenty. After thousands of pre-orders from its Kickstarter fundraising campaign, Six to Start is already planning for season two. "We've barely scratched the surface of what happened outside your base. There's a bigger world out there to explore." Daniel Nye Griffiths ***zombiesrungame.com***





5
glow graffiti
Paint with light

Playlist

CULTURAL PICKS OF THE MONTH
02.12

PHOTOGRAPHY: DAVE LIDWELL; MEGAN SHARP. WORDS: DAN SMITH

① VIVID VEHICLES

It's LEGO gone disco. Laser Pegs lets you build vehicles, including this star ship, with blocks that light up when they connect. It contains a "power base" and 32 pieces, each containing an LED. Illuminating stuff. *£27.99, firebox.com*

② ROBOT R&B

Like your soul with a big dollop of psychedelia? Think James Blake should have more swing? Then meet Lapalux – your new favourite act. *When You're Gone*, released on Flying Lotus's Brainfeeder label, is a kaleidoscopic, glitchy delight. *lapalux.com*

③ FREUD, REDRAWN

Graphic novel *The Wolf Man* recounts Sigmund Freud's most famous case study, Russian aristocrat Sergei Pankejeff. Adapted by Richard Appignanesi and endorsed by Freud's estate, it's worth a reading session on the couch. *£14.99, selfmadehero.com*

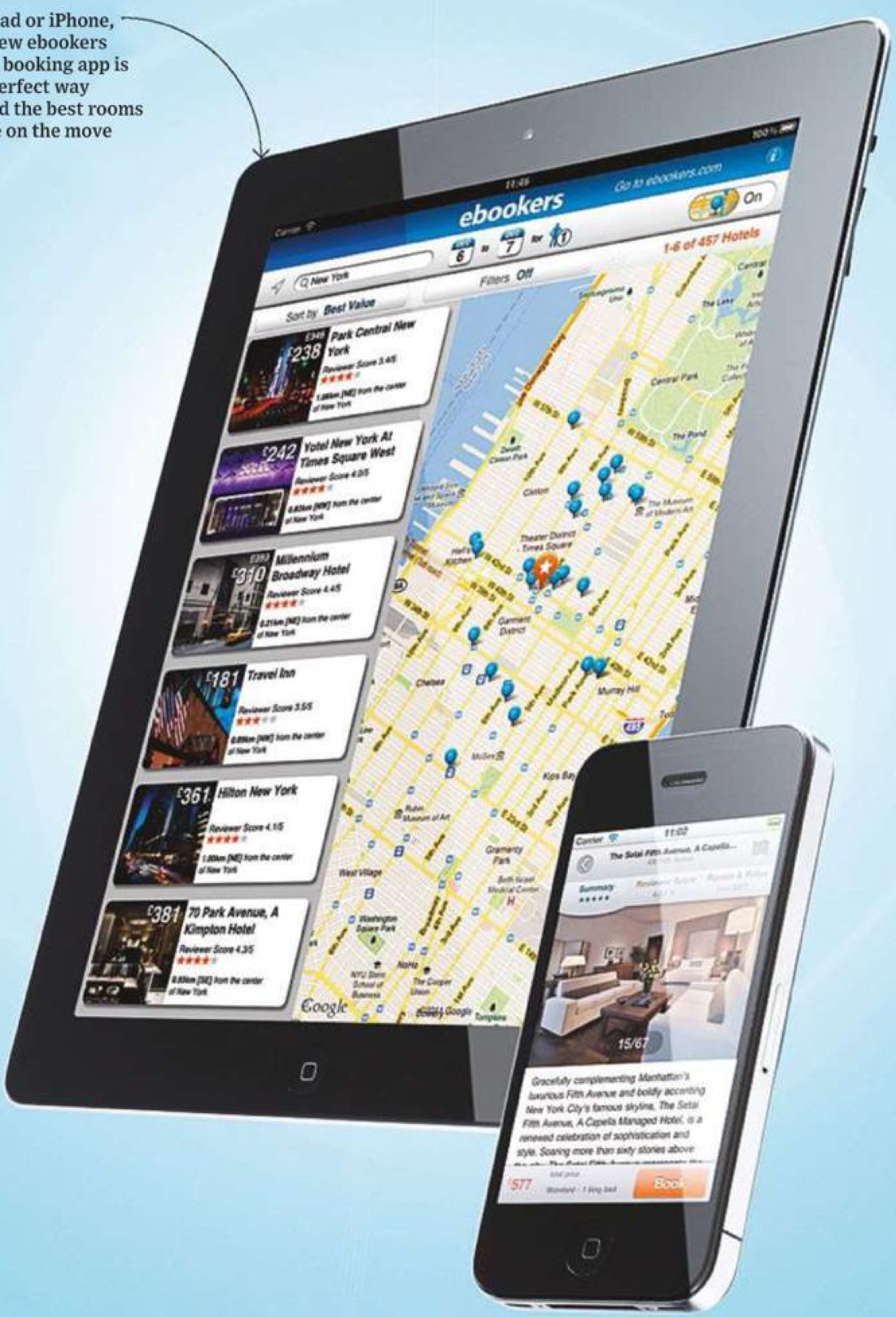
④ TOUGHER TUNES

The rugged Yamaha PDX-11 speaker has a dock for an iPhone/iPod touch, and takes six AA batteries for outdoor use. The octagonal body houses a 10cm woofer, plus a dedicated tweeter that hits all the high notes. *£129.99, uk.yamaha.com*

⑤ BRIGHTER BOMBING

Spray-paint art is cool, but it could earn you an Asbo. Paint with light instead: Glow Graffiti enables you to create art by "spraying" light on to a UV-activated canvas, or by shooting photos that record the trace of your LED-tipped can. *£35, suck.uk.com*

On iPad or iPhone, the new ebookers hotel booking app is the perfect way to find the best rooms while on the move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Book

ROOMS ON THE MOVE

In just three clicks you can book a room with ebookers' new hotel app for iPhone and iPad

Good news for anyone who has ever had to look for a hotel while on the go: there's an app for that. On the back of its mobile site and its award-winning inspirational iPad app, ebookers has produced a simple, powerful and fast hotel app designed specifically for travellers on the move. As well as using your iPhone's GPS capabilities to find the nearest hotels, it also allows you to search ebookers' entire selection of over 100,000 hotels – by city, address, postcode or landmark – and use its comparison tools for secure booking in just three steps whether you're in New York, Paris or Sydney. The app also has an interactive map, thousands of genuine reviews and complete hotel descriptions (with photographs).

Later this month, customers using the hotels app and mobile site (m.ebookers.com) will also be able to take advantage of Mobile Deals, which offers exclusive hotel discounts specifically designed for people on the move.

SEARCH
Find and compare nearby hotels using the interactive map

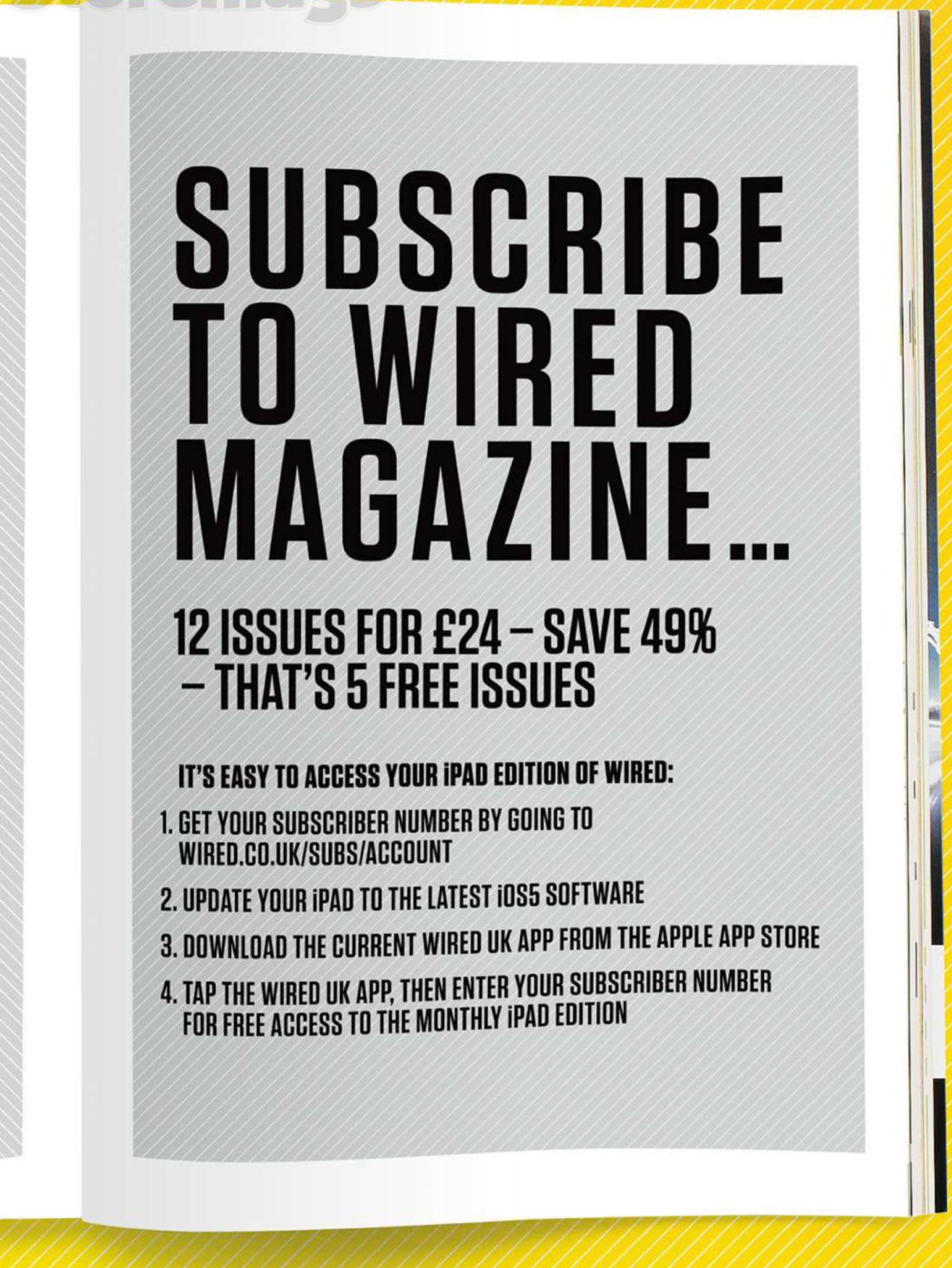
BROWSE
Look through thousands of hotel reviews

VIEW
Sort by price, star rating, review score and neighbourhood

BOOK
Simple booking process – easy to use in just three clicks

SPECIAL OFFER

The New Year is the perfect excuse to try out the new travel app. Make the most of the ebookers Travel Happier sale, which runs throughout January and offers up to 50 per cent off selected hotels.



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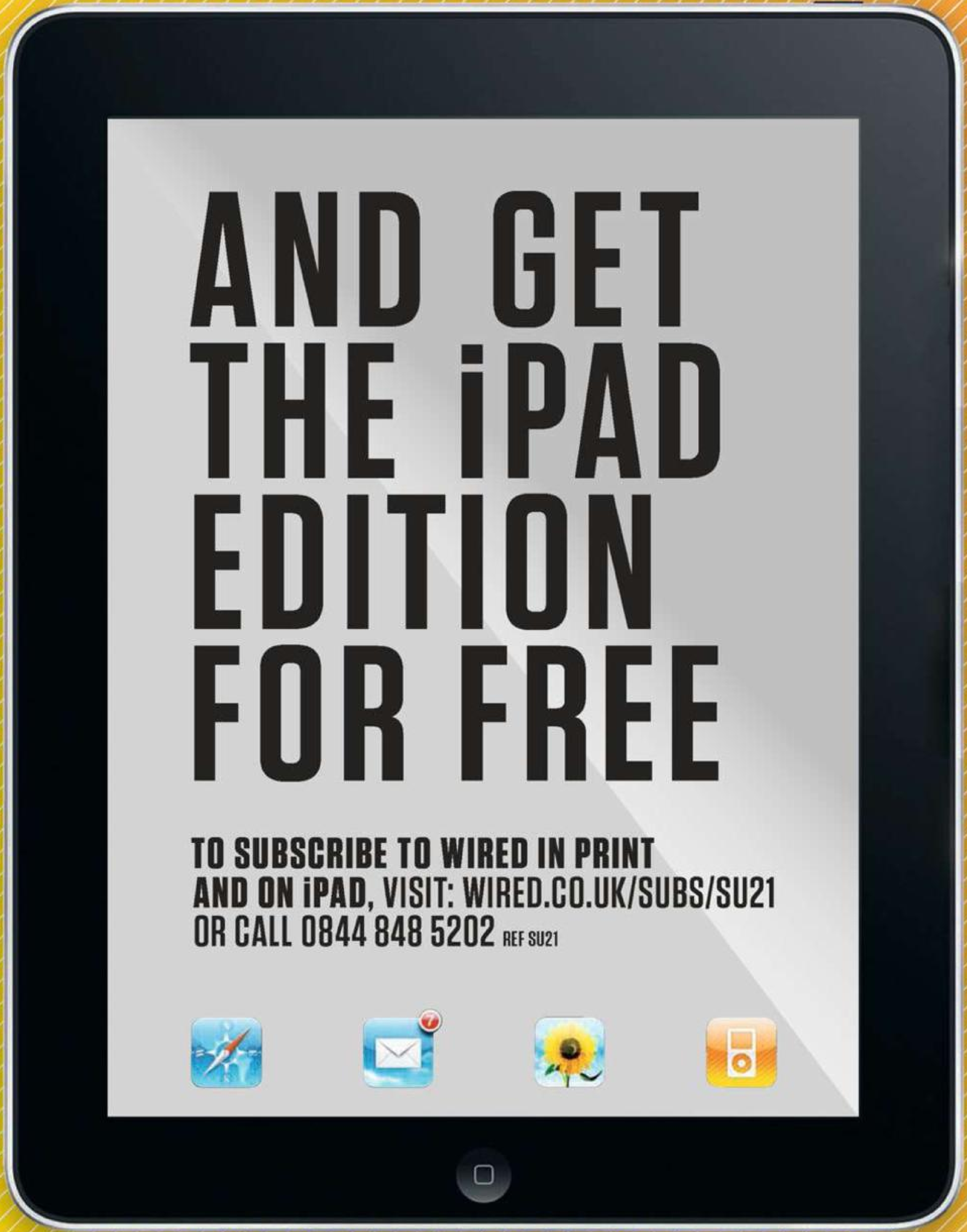

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JENNIFER LOPEZ
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HOW TO

BEAT THE BRAIN-FREEZE
THIS MONTH: 02.12
- TALK ABOUT PHILOSOPHY
- VALUE JEWELLERY
- WORK STANDING UP
- PROTECT MOBILE DATA

ILLUSTRATION: JIMMY ZOMBIE

COOK WITH LIQUID NITROGEN

The tool *du jour* of the more exhibitionist chefs, liquid nitrogen is good for more than school science demos. But you don't need a lab to use it at home. Craig McDonnell, head chef at Yorkshire's Gray Ox Inn (grayoxinn.co.uk), explains how. **Andrew Lowry**

● SOURCE IT

Gas or welding suppliers can sort you out. "They bring it in a big tanker, like in *Terminator 2*," says McDonnell. "There's no point trying to refrigerate it, but you should keep it in an insulated, open container. Make sure it's stored in a ventilated area, as the gas can make you light-headed."

● ● BE CAREFUL

"We don't wear gloves," says McDonnell. "To handle it, think of it as boiling water. If a few drops get on anything, it's like when you pour water in a red hot pan, and it bubbles and jumps around – it boils instantly." That said, if you spill enough on yourself, it'll certainly do some damage.

● ● ● MAKE ICE CREAM

It's simple to make ice cream with liquid nitrogen, and the vapour adds real drama. "At the point in the recipe when you'd put the ice cream in the machine or freezer, add liquid nitrogen – in 30 seconds it's done. It freezes so quickly you don't get any crystals, making it beautifully smooth."

● ● ● ● ...OR LOLLIES

Want some more show-off tricks to impress? Savoury ice lollies never fail. "Take a purée or sauce of pretty much anything and set it in gelatine, then dip it in liquid nitrogen," says McDonnell. "People are always surprised by how easy it is to make a roast chicken ice lolly."

HOW TO...

KEEP YOUR ELECTRIC CAR ON THE ROAD

There will be 3,000,000 electric vehicles on the roads worldwide by 2015, according to Pike Research. So if you've already taken the plunge and got yourself an electric vehicle (EV), how do you keep it ticking over efficiently? Alex Pierce, mobile technician at EV champions GoinGreen (goingreen.co.uk), gives his tips.

Ben Beaumont-Thomas

● LEAD-ACID BATTERY
This battery has the most potential pitfalls. "Give it a full charge once every four days," says Pierce. "If you're not using the EV for a couple of days, leave it on charge – and try to run it down to between 20 and 30 per cent once every five to ten cycles." Also "water" the battery every two weeks (more often if you're a heavy user) and do so on a level surface.

● ● LITHIUM-ION BATTERY
A new-generation battery that has double the range and three times the lifetime of lead-acid, but with one big flaw. "If you allow it to go flat, that's it, game over," says Pierce. "It has lots of fail-safes built in to stop it happening, but forget about the car for a couple of months and come back, and you've cost yourself several thousand pounds."

● ● ● OTHER FACTORS
If you've got an old direct current (D/C) electric motor, the motor brushes will need replacing every 9,500km. And after four days without a charge, inaccuracies creep in to the charging gauge. "The only time the car really knows how much charge it's got is when the battery is completely full," says Pierce.

HOW TO...

PROTECT THE PRIVATE DATA ON YOUR PHONE

Your mobile phone carries all sorts of details that could damage you in the wrong hands. Here's how you can protect it from prying eyes.

Matt Hussey

▲ REGISTER YOUR IMEI NUMBER
"The International Mobile Equipment Identity is used by police to trace a lost phone," says David Rogers, a mobile security expert. Network providers use it to block a stolen phone. It's usually found under the battery, or via the phone's settings. Register it at a site such as immobilise.com.

▲ ▲ REMOTELY WIPE ALL DATA
If you have lost your phone, you can clear the data before thieves download it. Android devices can use Google Sync along with Google Apps Device Policy to clear data remotely. Or download *Lookout*, which will do it for you. It's also available for BlackBerry and Windows phones.

meet me later
XO
XXXX
x
y
TIME KISS

ILLUSTRATION: ROBIN BOYDEN; DAVID LEMM; BEN MOUNSEY; JEREMY SLAGLE

▲▲▲ GET ANTIVIRUS PROTECTION
"Now is the time to protect against malware and viruses, particularly on Android phones. There are subtle ways for developers and fraudsters to get to your data," says Rogers. Most computer antivirus-software companies provide apps to keep out malware and viruses that grab data.

▲▲▲▲ DOWNLOAD A PHONE-FINDER APP
Most smartphones now have GPS tracking – which you can use to locate a lost phone. Microsoft offers a free app called *My Phone* for Windows Mobile. Apple's *Find My iPhone* app has been free since the introduction of iOS 4.2. Android users should try *Theft Aware*.

HOW TO...

MAKE THE FIRST KISS COUNT

Sheril Kirshenbaum is a research scientist and the author of *The Science of Kissing* (Grand Central). She explains the empirical and neurological observations that can help lead to improved osculation for you and your loved one. After all, you only get one chance to make a good first impression, so pay attention and pucker up.

■ GET TO KNOW EACH OTHER
When both partners take time to build a bond before their lips even meet, it can boost the "love hormone" oxytocin. This encourages a sense of attachment and builds an early emotional bond.

■■ PLAY UP YOUR ASSETS
For women, lipstick and plumping serums were designed for a reason – men respond to full, rosy lips. More than just cultural practice, full lips may indicate higher oestrogen levels and fertility.

■■■ FOSTER ANTICIPATION
Anticipating something makes obtaining it more satisfying – partly due to the neurotransmitter dopamine. So, if you dream about how the kiss will happen, the actual moment is likely to feel more romantic.

■■■■ STAY SOBER
Kissing can trigger the release of chemicals such as dopamine, serotonin and oxytocin which affect the way we feel. Additional substances – such as alcohol – stop us accurately interpreting the experience.

■■■■■ ORAL HYGIENE MATTERS
Scent and taste make a difference in a good kiss – particularly to women who, generally, have a stronger sense of smell than men. Brush and floss every day, and keep mints or gum handy so you'll be prepared.

■■■■■■ PICK THE MOMENT
Humans associate a good kiss with trust, so wait until it feels comfortable. Never pressure a partner, as it can raise the "stress" hormone cortisol. Kissing and cortisol don't make good chemistry.

■■■■■■■ DON'T WORRY
Kissing is a perfect example of nature and nurture complementing one other; we have an instinctive drive to connect this way but its expression is shaped by our culture and experiences.

■■■■■■■■ KEEP KISSING
A German study in the 80s found men who kissed their wives before work lived five years longer than peers who didn't. It's thought the kissers had a positive attitude, leading to a healthier lifestyle.

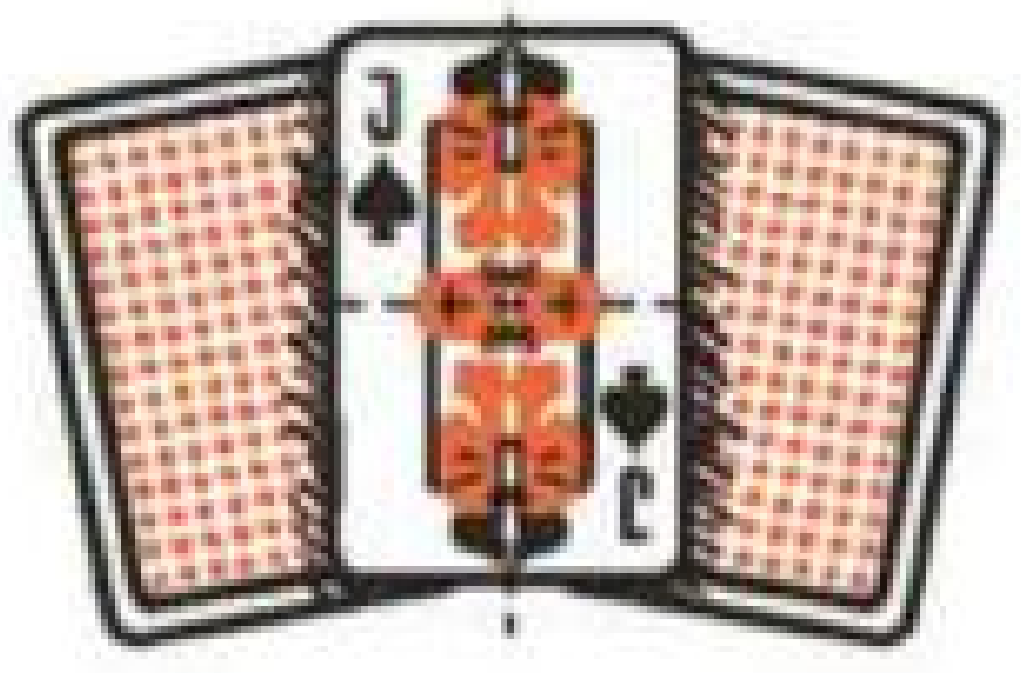
HOW TO...

USE GEOMETRY IN HOME DECORATION

Nature has geometric rules that can be replicated at home to create elegance and aesthetic correctness, as Kimberly Elam, author of *Geometry of Design*, explains. BBT

● LEARN THE RULE OF THIRDS
Divide a wall into thirds horizontally and vertically to create a grid, and hang pictures where the grid intersects. "This division of space feels very comfortable," explains Elam.

●● FIND GOLDEN SECTION POINTS
More pleasing is the point of intersection in a five-by-five grid of two columns from the right and two rows from the bottom. It was favoured by Renaissance painters as the best point to draw the eye to.



●●● PLAY WITH ASYMMETRY
"Hang five small pictures in a horizontal line on the wall," says Elam. "Take the second from the left or right, and raise or lower it. The eye will rest longer on the asymmetric composition."

HOW TO...

JUDGE JEWELLERY'S VALUE ON SIGHT

Jean Ghika, UK and Europe director at Bonhams auction house, explains what to look for to tell the bling from the tat. BBT

▲ IDENTIFY THE CARAT AND AGE OF GOLD

First, look for a UK hallmark, with a date letter, a sovereign's head and a number – "375", for example, stands for 375 parts of gold per 1,000, or nine-carat gold. "If it's a new piece with no marks, it's worth asking some questions," says Ghika. A hallmarking book will help, and signatures from famous houses such as Van Cleef or Cartier are useful indicators of added value.

▲▲ AUTHENTICATE PRECIOUS STONES

"It's important to have a gemological certificate stating that a stone comes from a particular region and it doesn't have any enhancement," says Ghika. If you're buying diamonds, make sure you have a certificate that assesses clarity and colour. Use a loupe magnification device to examine a piece for any marks, solder work or repair – and to check there are no stones missing.

▲▲▲ INVEST IN 20TH-CENTURY PIECES

"You need a lot of in-depth knowledge to buy stones and jewellery solely for investment purposes," says Ghika, but certain styles are likely to improve in value. "Trends are currently moving away from the Victorian era and towards 20th-century design. Look out for good quality art deco pieces, and 40s and 50s cocktail jewellery."

HOW TO...

TALK TO A PHILOSOPHER

Been cornered by AC Grayling at a drinks party? Talking to a philosopher can be an unnerving experience. Their concerns seem otherworldly, their discourse baffling. Follow our guide, however, and the experience can prove intellectually rewarding and even a little bit mind-blowing. Benet Brandreth

HOW TO...

RIP CD BOX-SETS IN iTUNES

Ripping large collections of discs is a laborious process. Make it easier with these tips by Kirk McElhearn, author of *Take Control of iTunes 10*. MH

■ FORMAT

To save hard-drive space, go to iTunes > Preferences, then click on Import settings. Choose Custom from the Settings pop-up menu; for Stereo bit rate, choose 64kbps; leave the sample rate at Auto and, from the Channels menu, choose stereo or mono – mono is fine for audio books.

■■ COMPILATIONS

"Compilation tracks won't show under the name of the artist," says McElhearn. A way round this is to check the Composers tag under the View > Column browser submenu. "In the same submenu, check Group compilations, and a Compilations entry appears on the Artists column."

● WESTERN ANALYTIC OR CONTINENTAL EASTERN?
Start by identifying which kind of philosopher you are talking to. Most will belong to the western analytic tradition, which runs from the ancient Greeks through to Descartes, and on to Bertrand Russell, Rawls and Singer. The analytic philosopher typically disdains continental or eastern philosophy as lacking intellectual rigour and offering only unquantifiable theories of the "good life".

● ● PREPARE FOR FRUSTRATION
A philosopher is quite capable of doubting whether the chair he or she is sitting in exists, or asking whether there is a universal property "chair" of which all chairs partake. If you think that sounds like nonsense, then you are missing the point. By questioning the basis for our knowledge that something exists, philosophers say we learn more about our assumptions, thought processes and use of language.

● ● ● PREPARE FOR EVEN MORE FRUSTRATION
If you hope to get a straight answer from a philosopher when offering a drink, prepare for disappointment. There are no "right" or "wrong" answers. It is not about finding answers as much as it is about asking questions and examining the basis for the answers we might give. For a philosopher, there is more fun to be had in picking those answers apart. Just buy them whatever you're having.

● ● ● ● TAKE ADVANTAGE OF ANALYTICAL RIGOUR
Philosophers spend a lot of time thinking about the big questions ("How do I know the Sun will rise tomorrow?"), and are skilled at argument and analysis. Use them as a whetstone to sharpen your views on fondly held theories against their analytical powers. You may come to abandon a favourite theory as unsound or discover new reasons for supporting it. Either way, you gain knowledge.

● ● ● ● ● REVEL IN THE MADNESS
Philosophers have developed some outstandingly bizarre theories. Ask them about McTaggart's theory, which claims that time does not, in fact, exist. Or demand to know more about Lewis's theory: for something to be possible there must exist a parallel world in which it actually happened. That is, if you truly exist. Or perhaps you can just show them this page, and save yourself the trouble.

ILLUSTRATION: ALEXEI VELLA; MATTHEW BILLINGTON; LUKE BOTT; MIKE LEMANSKI

■ ■ ■ RIP TIME
An external CD drive can speed things up. "A Mac Mini SuperDrive reads CDs at up to 24x. With a second optical drive on a Mac Pro, it speeds up to 52x," says McElhearn. Alternatively, rip to a computer with a small iTunes library, then transfer on to your main computer.

■ ■ ■ ■ QUALITY
iTunes is perfectly suitable for most CDs, but if you want flawless copies you'll need to look elsewhere, says McElhearn. "If you make an 'accurate rip' you can be sure the files are bit-perfect copies of your CDs." Use the free X Lossless Decoder (bit.ly/fyHrmS) to do this.

■ ■ ■ ■ ■ TAGS
iTunes' Gracenote will tag your burned songs. However, that database is limited – meaning more obscure tracks will have to be manually typed in. Other databases such as FreeDB (freedb.org) or MusicBrainz (musicbrainz.org) cover a wider range of music.

HOW TO...

WORK AT A STANDING DESK UNIT

You've adjusted your monitor, posture and chair, but the back pain won't go. Another option is a standing desk. Gina Trapani, founding editor of *Lifehacker*, switched a year ago. "I liked the idea of being active while engaged in work," she says. Be upstanding... Duncan Geere

▲ FIND YOUR DESK
If you're feeling flush, buy a desk designed to be set at multiple heights. Backinaction.co.uk has them at £800, or conset.org.uk has frames from £295.

▲ ▲ OR MODIFY YOUR OWN
If you just want to try out the concept, go the DIY route. Lift up your desk to the right height with packs of printer paper, or simply put shelves on it.

▲ ▲ ▲ IT MIGHT HURT AT FIRST
"I did not anticipate the extreme foot pain in the first week," says Trapani. She recommends a footrest so you can shift weight from one leg to the other.

▲ ▲ ▲ ▲ TAKE A BREAK
"After eight months of standing, I found by 3pm I was tired and a bit irritable," says Trapani. "I added a sit-down writing table, which is my break area."

▲ ▲ ▲ ▲ ▲ NOW ADD VARIETY
When you've mastered the standing desk, take it to the next level. A balance board, mini trampoline or treadmill under it will turn work into a workout.

IN THE NEXT ISSUE OF

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WIRED

ON SALE FEB 2

HOW I BUILT A £500M COMPANY

BY TUMBLR'S DAVID KARP

ALSO ON THE iPAD – NOW FREE TO SUBSCRIBERS

PHOTOGRAPHY: CHRIS CRISMAN

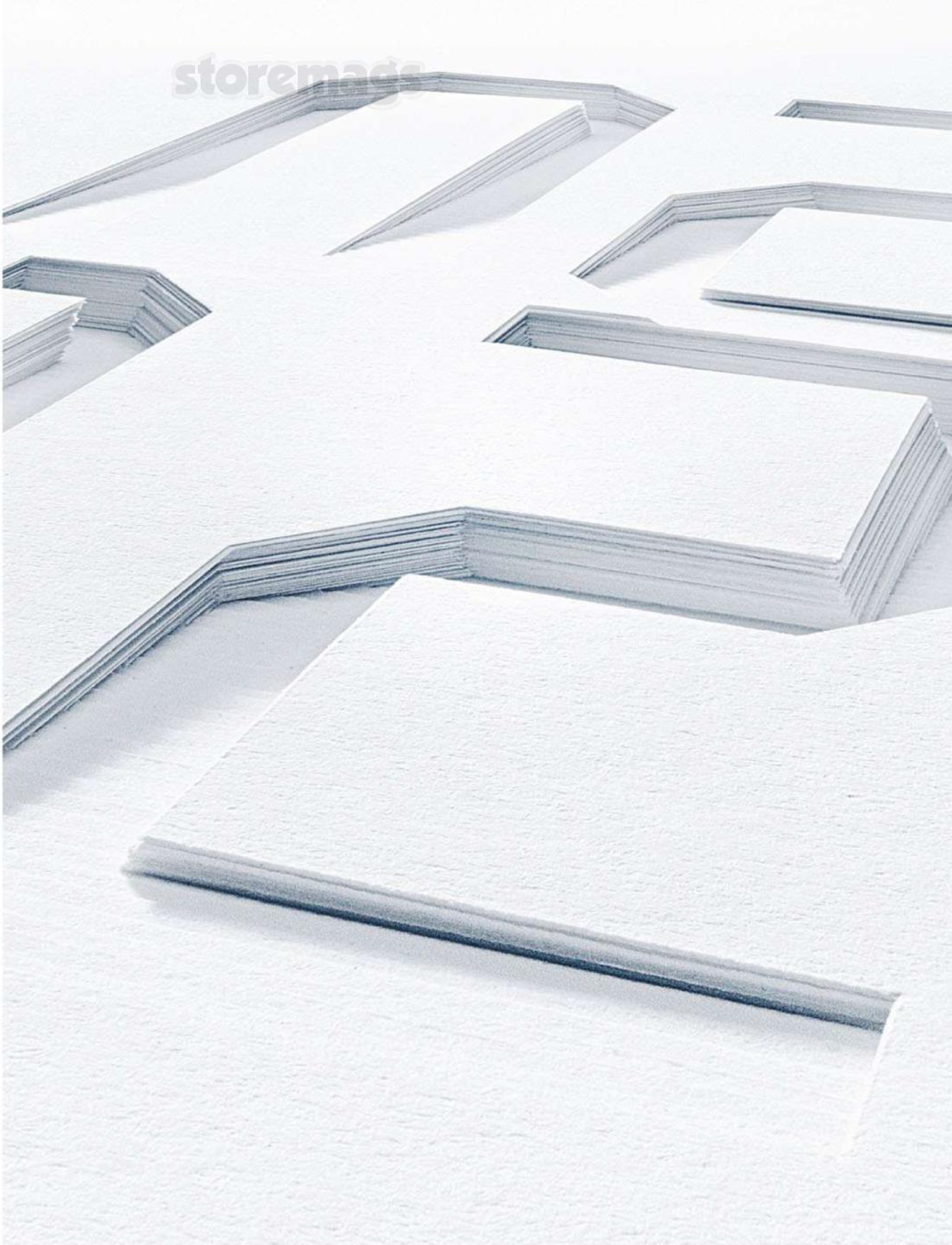

ILLUSTRATION: BIANCA CHANG, THE NUMBERS WERE HAND-CUT INTO 60 STACKED SHEETS OF 80GSM PAPER LAYER BY LAYER. PHOTOGRAPHY: SUN LEE

FEATURES/02.12

THE SMART LIST 2012 082 / WE GREW THIS HEADLINE 092 / ROBOT SEE, ROBOT DO 100
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50 PEOPLE WHO WILL CHANGE THE WORLD

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● ▼ ■ Welcome to the first WIRED Smart List. We set out to discover the people who are going to make an impact on our future – by asking today's top achievers who, emerging in their field, they'd most like to have a leisurely lunch or dinner with. So we approached some of the world's brightest minds – from Melinda Gates to Ai Weiwei – to nominate one fresh, exciting thinker who is influencing them, someone whose ideas or experience they feel are transformative. Some suggested names you may be aware of, others might be new. Either way, they're all people you really need to know about. And WIRED will be inviting all nominators and nominees to a giant dinner party...

● **RICHARD BRANSON** ENTREPRENEUR
▼ SELECTS
■ **LESEGO MALATSI** DESIGNER

Lesego Malatsi has a business called Mzansi Designers Emporium, based in Johannesburg. The company was mentored at the Branson Centre of Entrepreneurship in South Africa and it finds fantastic local fashion designers who are beginning to take their business overseas. It's doing great – it recently showcased its fashions at London Fashion Week. Organiser Fashion's Finest described the collection as "hotter than hot".

ILLUSTRATION: LYNDON HAYES. COMPILED BY ANDREEA VRABIE, SOPHIE HACKFORD, GREG WILLIAMS, TOM CHESHIRE, JOÃO MEDEIROS, DAVID ROWAN

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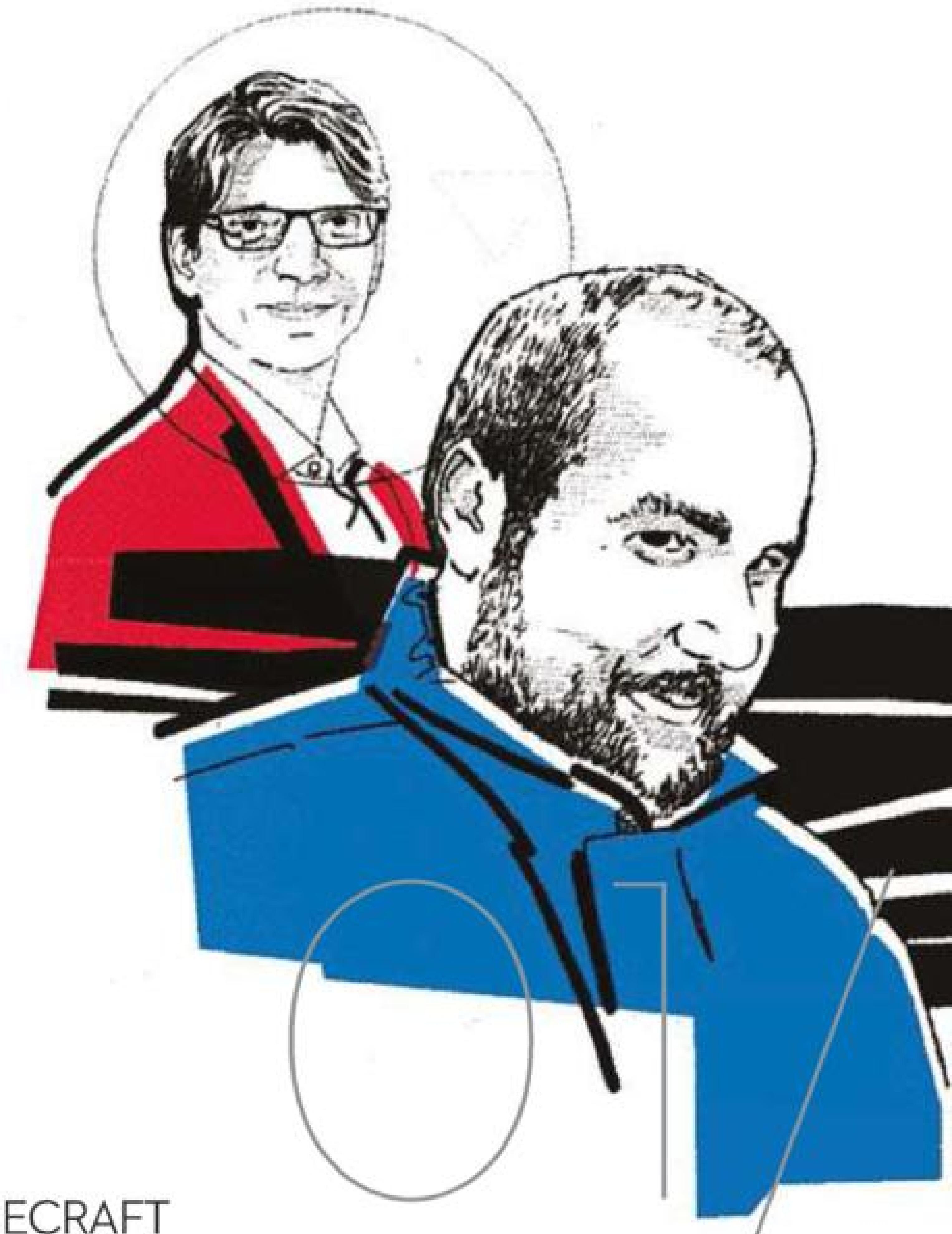

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02

● **NIKLAS ZENNSTRÖM** FOUNDER, ATOMICO;
COFOUNDER, KAZAA AND SKYPE
▼ SELECTS
■ **MARKUS ALEXEJ PERSSON** AKA **NOTCH** CREATOR, MINECRAFT

Notch saw a chance to create computer games in a different way, and executed it brilliantly. He does what all great technology entrepreneurs do: think globally, seeing the true potential for an online business, while understanding his customers. He's modest but confident in his area of expertise, and is always engaging. Besides, he is a fellow Swede who is creating an international success story.

● TECH ● SCIENCE ● ARTS ● BUSINESS ● DESIGN ● ACTIVISM ● GAMING ● ACADEMIA ● POLITICS

● **AARON KOBLIN**
CREATIVE DIRECTOR, THE DATA ARTS TEAM AT GOOGLE CREATIVE LAB
▼ SELECTS
■ **SID MEIER** GAME DESIGNER

As the creator of *Civilization*, Sid Meier has deconstructed the forces behind historical events and used computer simulation to recreate iterations of those rules and systems in an immersive and engaging gaming experience. Without Sid I'm not sure I would have begun to respect how fascinating our history and our cultures really are; or how much I could really enjoy a good video game.

● JANE MCGONIGAL GAME DESIGNER
▼ SELECTS
■ VINCENT HORN AND ROHAN GUNATILLAKE THE BUDDHIST GEEKS

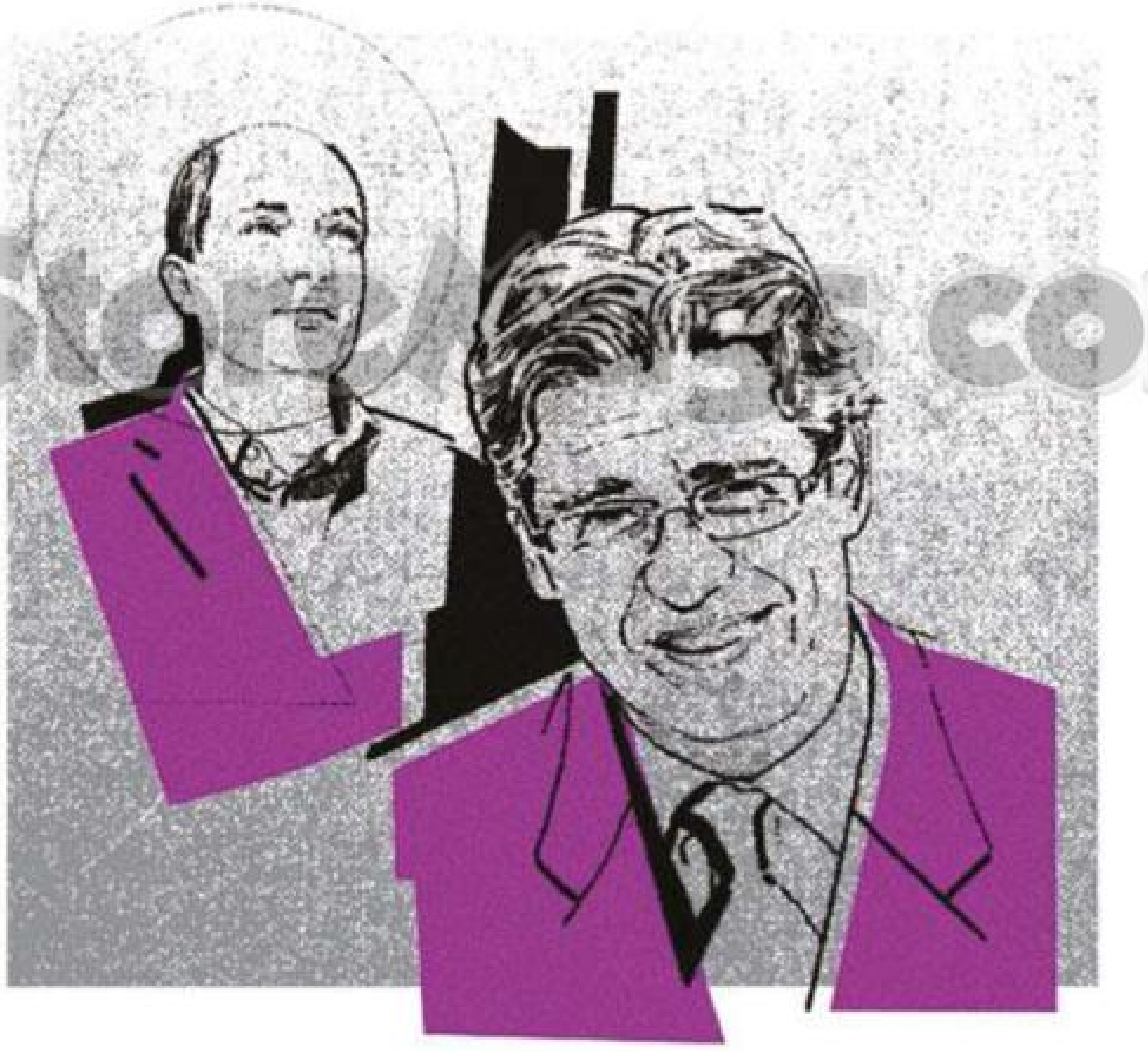
I'm a geek. I'm also a practising Buddhist. That's why, of everyone on the planet, I'd most like to lunch with the founder of Buddhist Geeks, Vincent Horn, and the cofounder of the Buddhist Geeks conference, Rohan Gunatillake. What's a Buddhist geek? It's someone with an interest in technology and Buddhist wisdom who wants to figure out how to use technology to reinvent a thousands-year-old spiritual practice to be more accessible, more relevant and easier to integrate into our lives. They're asking big questions, such as "How can social media support meditation practice?" "How can design thinking change the way ancient wisdom is taught and passed on?" "Can videogames lead to enlightenment?" I'm particularly passionate about that last question!

● **JOHN BROCKMAN**
PRESIDENT, THE EDGE FOUNDATION
▼ SELECTS
■ **JENNIFER JACQUET**
POSTDOCTORAL RESEARCHER

She is intellectually fearless, deeply serious about science, personally effervescent and always curious. Her interests are environmental sustainability (particularly fish), the evolution and function of guilt, honour and shame, and the role of IT in shaping environmental action – all of which fall under a broad interest in the tragedy of the commons. Penguin publishes her *Is Shame Necessary?* soon.

● **GEOFFREY WEST**
THEORETICAL PHYSICIST
▼ SELECTS
■ **DAVID KRAKAUER**
EVOLUTIONARY BIOLOGIST

David Krakauer is a true polymath, full of ideas and creativity. He comes out of evolutionary biology at Oxford and was at the Institute for Advanced Study, Princeton, for several years before becoming a colleague of mine at Santa Fe Institute. He has written papers with fellow biologists Martin Nowak and Mark Pagel and was recently recruited to run the new Winsconsin Institute for Discovery – it's broad and trans-disciplinary in outlook, though centred on the biosciences.



● **ESTHER DYSON** INVESTOR AND ENTREPRENEUR
▼ SELECTS
■ **NATHAN EAGLE**
CEO, TXTEAGLE

Nathan Eagle is not just smart; he applies his intelligence to the real world, with both vision (mobile phones as capital equipment enabling millions of people around the world to become productive), and a business model (get them to collect data and market research for large companies). His company, Jana (in which I've invested), employs thousands and, ultimately, he employs millions of people in emerging markets as market researchers.

● ALAIN DE BOTTON PHILOSOPHER
▼ SELECTS
■ JOHN ARMSTRONG PHILOSOPHER

The writer and philosopher John Armstrong [author of *In Search of Civilisation: Remaking a Tarnished Idea*] is a very bold thinker, arguing that capitalism has gone wrong not because there aren't enough regulations on businesses but because there isn't enough education of consumers. In his eyes, the task is not to ban McDonald's, but to educate our desires so that we might "freely" consider alternatives. This is thinking at once boldly left- and right-wing.

● **JUAN ENRIQUEZ**
LIFE SCIENTIST
▼ SELECTS
■ **ED BOYDEN** OPTOGENETICIST

Ed Boyden's research at MIT founded the field of optogenetics. Now we can observe how a brain reacts as it hears, feels, sees, smells, remembers, loves. But perhaps more interesting, scary and weird is that he's developed ways to promote or suppress memories and feelings by using fibre-optic light. Eventually, people may even be able to upload or download their memories.

● TECH ● SCIENCE ● ARTS ● BUSINESS ● DESIGN ● ACTIVISM ● GAMING ● ACADEMIA ● POLITICS

ILLUSTRATION: LYNDON HAYES

● **JOI ITO**
DIRECTOR, MIT MEDIA LAB
▼ SELECTS
■ **CESAR HIDALGO**
NETWORK SCIENTIST

Hidalgo is a young academic bringing economics, networks and data science together to help understand the various complexities of economic growth.

● **MATT RIDLEY**
WRITER
▼ SELECTS
■ **REUBEN ABRAHAM**
ECONOMIST

He's probably the smartest, coolest and funniest economist I know, with an unrivalled and unsentimental understanding of the economic development of Asia and indeed the world. He teaches in India but plutocrats such as Bill Gates seek his advice on how to catalyse growth in emerging markets. He champions development through trade and tech for Asia and Africa, which he says has a bright future because it's following the path of trade-driven growth in living standards.

03/14

● **AI WEIWEI** ARTIST
▼ SELECTS
■ **CHEN GUANGCHENG** HUMAN-RIGHTS ACTIVIST

Chen Guangcheng is an activist from Shandong who lost his sight as a child; but he is a bright light that shines in the darkness. Without any professional training, he taught himself law to help himself and other disabled people and disadvantaged groups in rural areas. Outside China, he is best known for filing a lawsuit on behalf of women who suffered under China's forced-abortion and sterilisation campaign. He has also fought for more equitable taxation of villagers and disabled people. He's suffered a series of house arrests, detentions and trials and is currently confined to his home, along with his wife and daughter. Constantly under surveillance by agents and hired villagers, he's prevented from communicating with the outside world. But in February 2011 he smuggled out of the village a homemade video that described his situation. After this, he and his wife were reportedly beaten and their computer, video camera, audio recorder and TV aerial, as well as legal documents relating to his case, were confiscated. The windows of the family house were covered with metal sheets. His bravery, persistence and thirst for justice are great inspirations. I would like to take this opportunity to express my respect for him and to send him my best. It would be an honour for me to meet him one day.

● **DAN ARIELY**
BEHAVIOURIAL ECONOMIST
▼ SELECTS
■ **MICHAEL NORTON** SOCIAL SCIENTIST

Mike Norton is one of the most creative social scientists I know. By asking unusual questions about the relationship between wealth and happiness he comes up with very interesting findings, observations and conclusions. There's a significant amount of literature on the theory that, as people become richer, they don't necessarily become happier. Norton asked instead whether people know *how* to use money to buy happiness. He asked: if you give money to people, what do they do with it? The answer was that they spend it on themselves. He then posited: what if we ask people to spend money on other people? His research revealed that those people are actually happier as a consequence. This worked with individuals, and also with groups – when people spent money on people they worked with, the team became more productive. He and I have been working together to try to figure out what level of wealth inequality people in developed countries are willing to tolerate. What we found is that people want to live in societies that are much more equal and much fairer than currently. So why are we willing to tolerate the current level of inequality? We don't have the answer for this yet.

● **DANIEL KAHNEMAN**
PSYCHOLOGIST AND NOBEL LAUREATE
▼ SELECTS
■ **SENDHIL MULLAINATHAN**
PROFESSOR OF ECONOMICS, HARVARD UNIVERSITY

Sendhil Mullainathan is a rising star in behavioural economics. His work on the psychological traps of property may introduce a new paradigm for joining psychology, economics and policy.

● **ROHAN SILVA**
SENIOR POLICY ADVISER
TO DAVID CAMERON
▼ SELECTS
■ **CARLO RATTI**
DIRECTOR, SENSEABLE
CITY LABORATORY, MIT

Carlo Ratti is at the forefront of thinking about the way in which technology can be used to rewire cities, making them more energy efficient, reducing traffic congestion and stimulating new entrepreneurial activity. With half of the world's population now living in urban areas, Ratti's work could have an impact on the lives of billions of people in the years ahead.

● **ESRA'A AL SHAFEI**
INTERNET ACTIVIST,
FOUNDER AND DIRECTOR
OF MIDEASTYOUTH.COM
▼ SELECTS
■ **YANA BUHRER TAVANIER**
HUMAN-RIGHTS ACTIVIST

My choice is a Bulgarian activist and investigative journalist working to expose the inhumane treatment of children and adults with disabilities and mental illness in the Balkans. She's also a prominent member of the Bulgarian LGBT-rights movement but her influence expands beyond Bulgaria. We met at TED. She is dedicated and committed to making change, which she will achieve.

● **FABIOLA GIANOTTI**
PARTICLE SCIENTIST, CERN
▼ SELECTS
■ **NIMA ARKANI-AHMED**
THEORETICAL PHYSICIST

Now at Princeton's Institute for Advanced Study, he is one of the most outstanding theorists in fundamental physics today, in spite of his young age. For instance, he has proposed pioneering ideas to reconcile gravity with the other forces. Not only a brilliant thinker, he's also lively, full of ideas and energy, and has a good sense of humour. A very enriching person to be around.

Sto s.com

● **CARLO RATTI**
DIRECTOR, SENSEABLE
CITY LABORATORY, MIT
▼ SELECTS
■ **SALMAN KHAN**
FOUNDER,
KHAN ACADEMY

Higher education urgently needs to be reinvented while the world is trying to cope with an unprecedented demand from youth in emerging countries. It's vital that all of us – researchers, teachers, academics – look at how new technology can help with this. Mr Khan is one of the people doing exactly this, through his online Khan Academy (*khanacademy.org*).

● **JULIA HARTZ**
PRESIDENT, EVENTBRITE
▼ SELECTS
■ **LEILA JANAH** WINNER,
WORLD TECHNOLOGY
AWARD FOR SOCIAL
ENTREPRENEURSHIP 2010

Leila inspires me as an entrepreneur because she's truly bold in the risks she takes to help alleviate poverty, empower women and take advantage of technology to achieve her mission. Through her social business, SamaSource, she champions microwork: small, computer-based tasks that generate life-changing income for women all over the world – empowering them with marketable skills. What is genius about her approach is the way in which she leverages the newest, most effective technology, such as Facebook, iOS and CrowdFlower, to extend her reach to anyone around the world. The winning ingredient of her business model is the ease with which her customers connect with the microwork network through lightweight applications. I've had the pleasure of meeting and working with her and I find her to be incredibly humble, focused and relentless in her pursuit to change the world.

● JIMMY WALES FOUNDER, WIKIPEDIA
▼ SELECTS
■ ANDREY ANDREEV FOUNDER, BADOO

I'm intrigued by Badoo's growth to over 120 million users in an under-the-radar way. Its founder, Andrey Andreev, has been called secretive and mysterious, but when I met him (once, at Founders Forum in the UK) he seemed neither; just your typical smart, serious, interesting tech geek on a mission to create something that people like. I've tested Badoo which, as a dating site, isn't something I'm in the market for myself, but I'm impressed with how it works, and fascinated by the game-like business model.

● **DANNY HILLIS**
INVENTOR AND ENTREPRENEUR
▼ SELECTS
■ **JEHANE NOUJAIM** DOCUMENTARY DIRECTOR

In a world of increasing polarisation, documentary film-maker Jehane Noujaim (*Startup.com, Control Room* and *Pangea Day*) seeks the understanding that comes from empathy with multiple perspectives. One of the great battles in the world right now is between the self-righteous monoculturalist (Rush Limbaugh, Michael Moore) and the open-minded multiculturalist. People tend to listen to those who reinforce their view: I see Noujaim as a game changer because she makes films that encourage you to see other viewpoints. In the battle for the mindset of our future civilisation, I'm rooting for Noujaim.

● **CATHERINE MOHR**
ROBOTICIST/ DOCTOR
▼ SELECTS
■ **MARILYN WARING**
HUMAN-RIGHTS ACTIVIST

Marilyn Waring is an extremely clear thinker about the disastrous consequences of using measures such as GDP as a surrogate for "progress" or "wellbeing" in a country. She has also analysed how economics as it is currently practised as a "science" is radically defective and that it drives decisions in globalisation that have unintended but terrible consequences for the world. We must realise that we can't tackle the problems in health care, environmental issues, food security, democracy and women's rights in isolation; they must be seen as a set of interrelated issues, and anyone who wants to make a difference in the human condition must look at all of these factors. Waring has taken these issues head on, with the courage to call for new measures for what we call progress so that we stop rewarding moving away from what should be our global goals.

● **YOSSI VARDI**
ENTREPRENEUR
▼ SELECTS
■ **SHAI RESHEF** EDUCATOR

Shai has revolutionised the way higher education can be provided to millions of young, capable people in emerging economies. He is using internet tools to provide free online higher education over the net. After having had a successful for-profit career in supplementary education, he is dedicating his life and resources to this new social initiative. He will change the outcome of many youngsters.

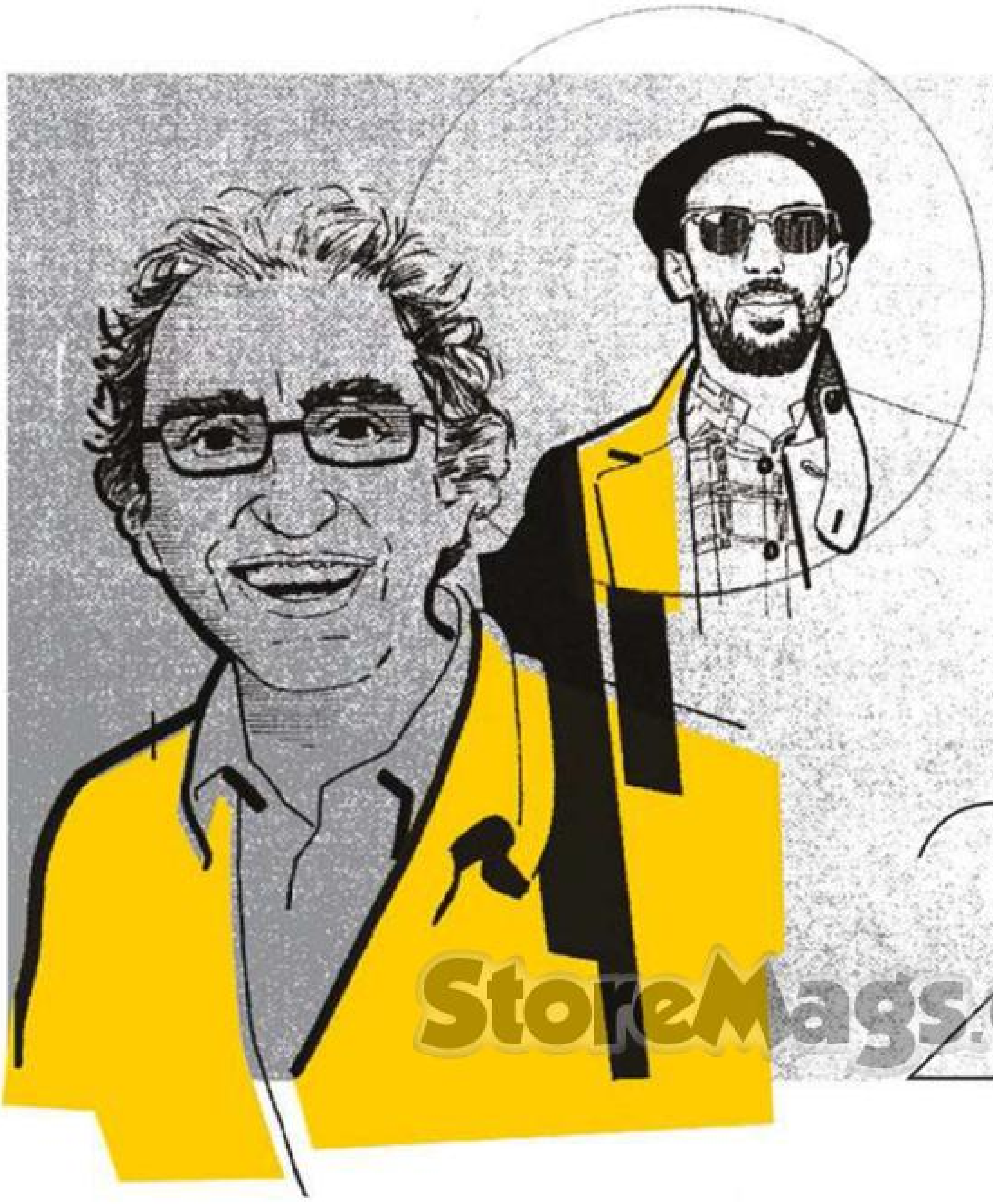
ILLUSTRATION: LYNDON HAYES

● **STEPHEN EMMOTT** HEAD OF COMPUTATIONAL SCIENCE, MICROSOFT RESEARCH CAMBRIDGE
▼ SELECTS
■ **DREW PURVES** COMPUTATIONAL ECOLOGY AND ENVIRONMENTAL SCIENCE GROUP (CEES), MICROSOFT RESEARCH CAMBRIDGE

Drew is an absolutely amazing once-in-a-generation young scientist whose work is set to completely shake up science, intergovernmental policy and technology in what is arguably the most important societal challenge we face: climate and ecology. An immensely inspiring, original thinker and a gifted and technologically/computationally savvy scientist, his ideas are unquestionably going to be influential both in science, policy and technology. In my opinion, Drew should be on WIRED's front cover, let alone on WIRED's radar, because he will be one of the key influencers in the science and the technology of climate and ecological science.

● **JR** ARTIST/PHOTOGRAPHER
▼ SELECTS
■ **MARCO BERREBI** PHOTOGRAPHER

Berrebi is a visionary because he always clearly separates the financial interest and the artistic vision of any project. An idea for him should be like an equation: either it works, or it doesn't; but there should be no compromise. The beauty of his work is getting to this equation; it's a long road but maybe, for him, this is the art.



15/25

● **REID HOFFMAN** FOUNDER, LINKEDIN
▼ SELECTS
■ **JOI ITO** DIRECTOR, MIT MEDIA LAB

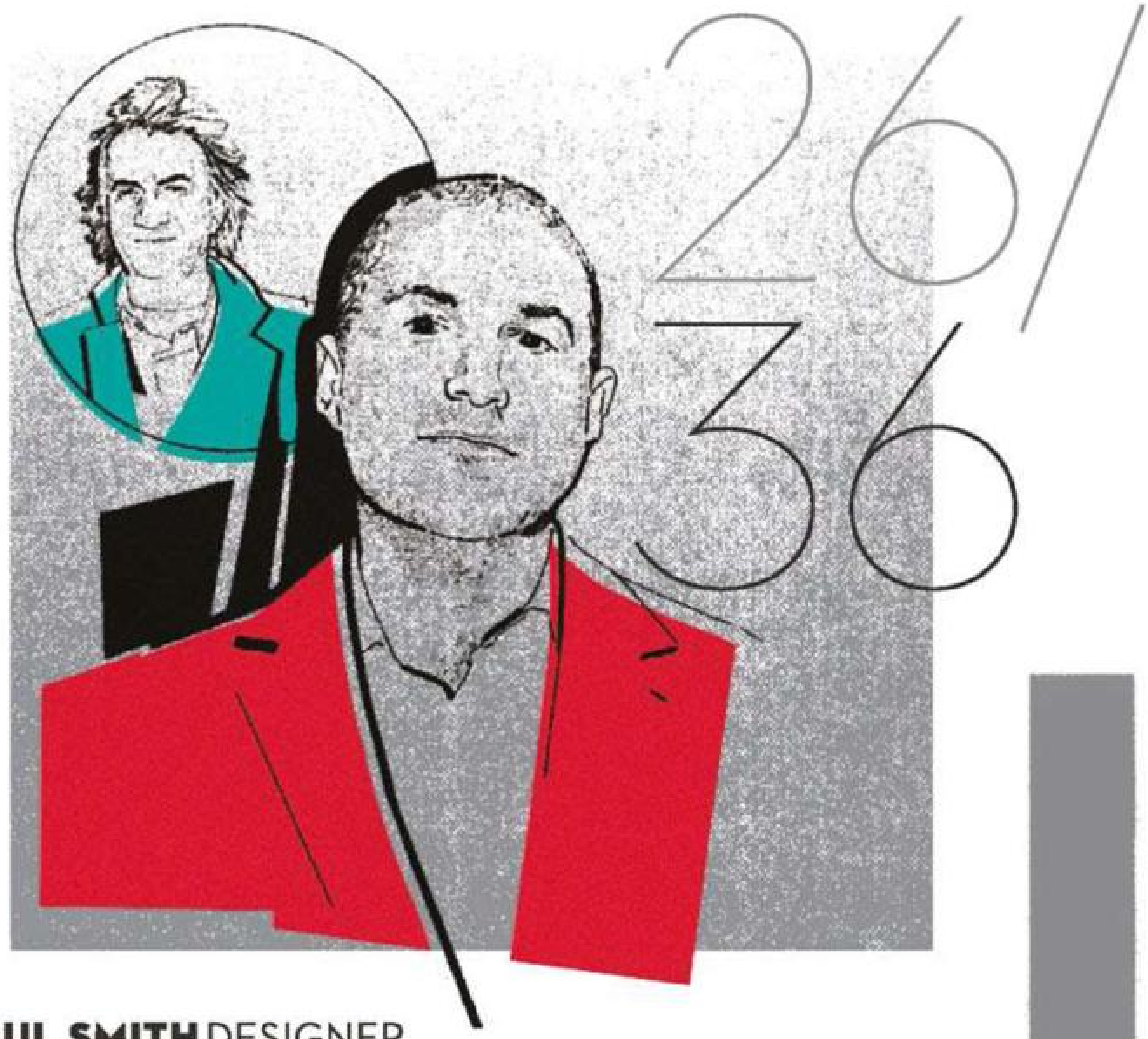
He has had amazing influences upon the web – he and I invested in Flickr – but he'll make an important transformation of education with Media Lab. He'll work with the faculty on a curriculum to integrate a bias to action as part of preparation for life, similar to "be the entrepreneur of your own life". And he'll work on connecting academic and industry research programmes for strong mutual value – eg open-source hardware.

● **LISA RANDALL**
PHYSICIST
▼ SELECTS
■ **ZOHAR KOMARGODSKI**
SCIENTIST

Komargodski has made several important contributions to developments in field theory. With Adam Schwimmer, he proved a result that had been conjectured for years about how a particular quantity changes with energy. He has also made developments in what are known as supersymmetric theories, proving exact results or coming up with new interpretations in what were thought to be well-trodden regimes.

● **YVES BÉHAR**
INDUSTRIAL DESIGNER
▼ SELECTS
■ **ISSEY MIYAKE**
FASHION DESIGNER

Issey Miyake is exactly what I look for in a designer: industrious, groundbreaking and an inventor at heart. Transcending his field and inspiring architects and designers is a huge contribution in itself, but he also creates his own world of industrial, structural and visual language that can be worn to amazing effect. His creativity never stops and he continues to search for more.



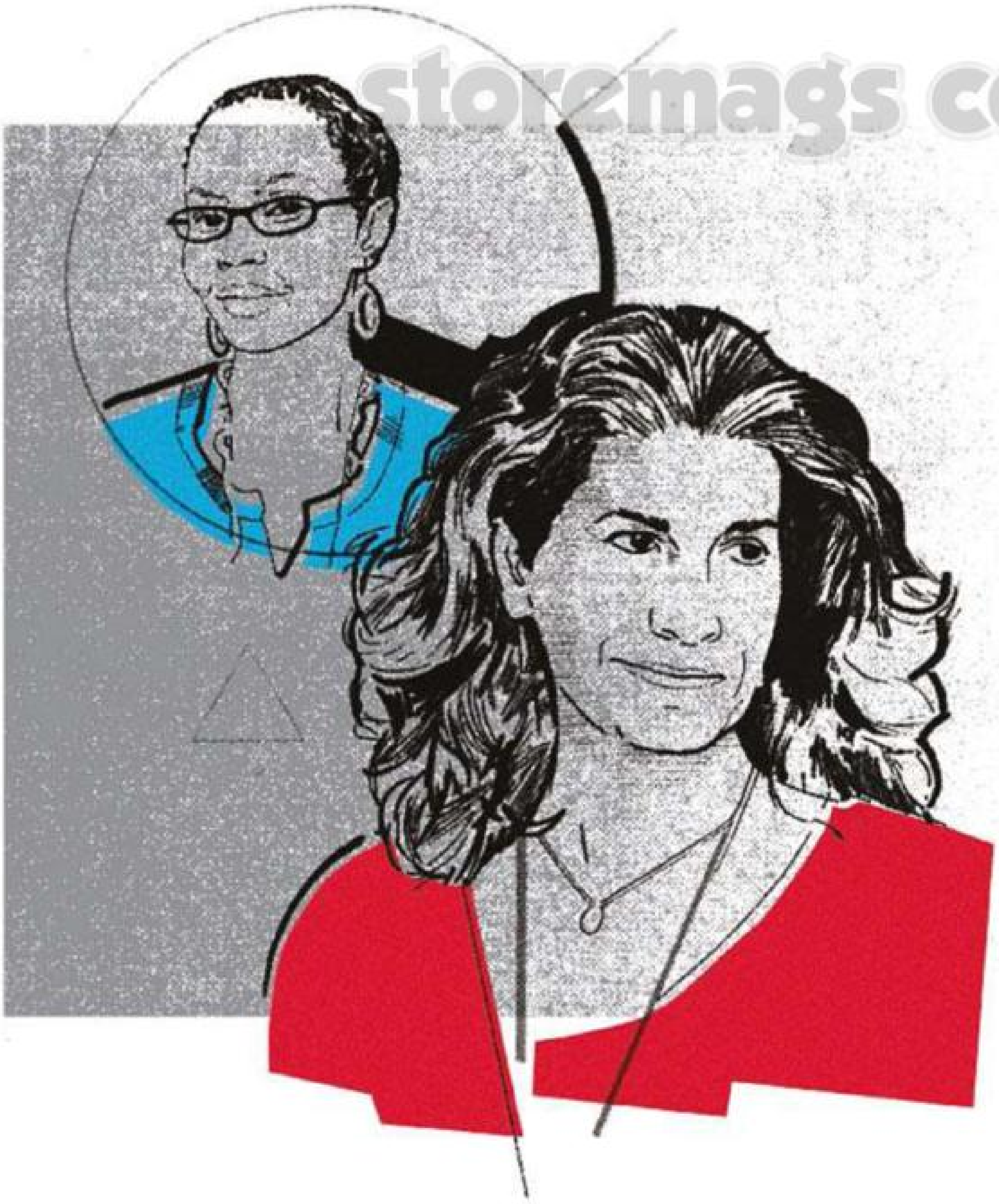
● **PAUL SMITH** DESIGNER
▼ SELECTS
■ **JONATHAN IVE** SENIOR VICE-PRESIDENT, INDUSTRIAL DESIGN, APPLE INC

I see Jonathan a few times every year, but unfortunately he mostly pops in during one of his London visits and we never really have enough time for a leisurely lunch due to both of our schedules being very hectic. I would choose him because I enjoy the way he thinks about things and the observations that he makes. We all know what amazing things he has achieved at Apple.

● **CLAY SHIRKY**
INTERNET EVANGELIST
▼ SELECTS
■ **AMIRA AL HUSSAINI**
JOURNALIST AND BLOGGER

Operating as *@JustAmira*, Al Hussaini coinvented the curated, personal news feed as a journalistic form. The thing that sets her apart from peers such as Sultan Al Qassemi and Andy Carvin is that she became an actor in the events she covered. She exhibited scepticism that the Arab Spring would come to her native Bahrain, but as the Al Khalifas' reactions to the uprisings in Tunisia and Egypt became more strident, she questioned their motives and suggested that they should not be afraid of sharing political power with their people. But her calls for openness became too much – she was added to a list of enemies of the state, went into hiding, and was eventually spirited out of the country to Berlin, where she continues to write about the Arab Spring. I admire her for her intellect, for her sense of what new media forms make possible, for her political commitment, and for her bravery. I communicated with her last spring to wish her well when she was a wanted woman, but we've never met. She's the name I'd add to this fantasy team.

ILLUSTRATION: LYNDON HAYES



● **JULIANA ROTICH** PROGRAMME
DIRECTOR, USHAHIDI.COM
▼ SELECTS
■ **DEBORAH ESTRIN**
COMPUTER SCIENTIST

Deborah Estrin is trailblazing the development of embedded networks by laying the foundations for the internet of things, participatory sensing and the future of smart cities at the University of California, Los Angeles (UCLA). The promise of merging the internet of things with crowdsourcing could boost further collaborative, participatory sensor data and crowd-intelligence-based forms of problem-solving and civic engagement.

● **IAIN SINCLAIR**
WRITER
▼ SELECTS
■ **DON DELILLO**
WRITER

"It takes time to lose interest in things," DeLillo wrote. And time, American time, at home and abroad, looking out and looking back, is what he has and what he trades in. Historic time leaves you in difficult places: borders, transits, waiting rooms, deserts, runways, oceans, cities. DeLillo has such an instinct about where to start, where to position himself in the room. I admire the way the work gathered itself over the years, building up to the big wave, and then took time – time again – to study patterns left in the sand. Aftershocks and meditations in stripped-down sets. In other words, that mystery of craft...

● **JUNE COHEN** EXECUTIVE
PRODUCER, TED MEDIA
▼ SELECTS
● **PATTIE MAES** FOUNDER,
MIT FLUID INTERFACES GROUP

Maes is one of the most original and influential thinkers exploring how humans and computers interact, and how machines can augment human intelligence and experience. She is not a public-facing intellectual. It took me four years to convince her to speak at TED, but it was worth the effort: her talk has been one of our top five most-viewed for three years. In the 90s, she pioneered what was then known as collaborative filtering – the now-common practice of a system generating recommendations for a consumer by comparing them to similar consumers. I'd be fascinated to hear her thoughts on some philosophical questions: how do you capture the intelligence of a single human? How can computers bring us closer to those we love? How can ubiquitous computing help us make better decisions and live happier lives? I, for one, would like to know...

● **PETER DIAMANDIS**
CHAIRMAN, X PRIZE
FOUNDATION
▼ SELECTS
● **JEFF BEZOS** CEO, AMAZON

I first met Jeff in the early 80s when he was at Princeton. He has an underlying passion: opening up the space frontier. He's also one of the few individuals with sufficient wealth to actually pull it off...

● **LEILA JANAH**
FOUNDER, SAMASOURCE
▼ SELECTS
● **ROBYN SCOTT**
COFOUNDER, ONELEAP

She figured out the best way to affect Aids in Botswana was to tell a story that would compel people to act. The story in her memoir *Twenty Chickens For A Saddle* was hers, but it was motivated by interest in others.

● **TINA ROSENBERG** PULITZER
PRIZE-WINNING WRITER
▼ SELECTS
● **SRDJA POPOVIC**
SOCIAL ACTIVIST

Popovic is the executive director of the Belgrade-based Center for NonViolent Action and Strategies (Canvas). He was one of a handful of students at Belgrade University who, in 1998, established Otpor ("resistance"), a political movement aimed at overthrowing Slobodan Milosevic. Instead of marches and speeches, Otpor relied on street theatre and pranks – their guiding spirit was *Monty Python's Flying Circus*. After two years, Otpor had 70,000 members, and Milosevic fell.

Now Popovic travels the world teaching these methods to other democracy activists. Early victories came with the Rose Revolution in Georgia and the Orange Revolution in Ukraine and, recently, many of the tactics in Tahrir Square were taught to the April 6 movement by Canvas. Popovic argues that nonviolence is not only the moral choice for overthrowing a dictator, it's also more effective than taking up arms. His ideas deserve to be known around the world.

● TECH ● SCIENCE ● ARTS ● BUSINESS ● DESIGN ● ACTIVISM ● GAMING ● ACADEMIA ● POLITICS

● **TIM BROWN** CEO, IDEO
▼ SELECTS
■ **WENDELL LIM**
SYNTHETIC BIOLOGIST

Wendell runs a lab at the University of California, San Francisco, focusing on synthetic biology, which in my opinion is likely to be the next technology wave after the social internet. What makes Wendell especially interesting is that, alongside his laboratory science, he is studying how design might impact his work and how his work impacts design. He has even had a team of industrial designers working with him in the lab on some experiments. He's going to be an important voice in this new science.

● **DAVID DEUTSCH**
QUANTUM PHYSICIST
▼ SELECTS
■ **HAGAR GELBARD-SAGIV**
SCIENTIST

Research into aspects of human brain function is deeply important and is going to expand rapidly as technology progresses. But it's an area that is prone to being led down blind alleys by bad philosophy. I'd want to grill Gelbard-Sagiv on whether she understands the role of philosophy in fundamental science, and whether she gets it right.

● MELINDA GATES
COFOUNDER, BILL & MELINDA GATES FOUNDATION
▼ SELECTS
■ TEDROS ADHANOM GHEBREYESUS
MINISTER OF HEALTH, ETHIOPIA

Dr Tedros has used innovative techniques to save the lives of millions of Ethiopians. Rather than building expensive hospitals, he has set up programmes to train 35,000 health workers. The workers then go on to provide care in nearly every community across Ethiopia – especially for women and children, who are often the most vulnerable and underserved. As a result of this, women have access to family planning and are now able to plan the timing and spacing of their children. And children now receive life-saving vaccines and treatment for deadly illnesses such as pneumonia, malaria and diarrhoea. In five years, his work has reduced the death rate of Ethiopian children under five by 28 per cent. Does it get more inspiring than that?

● **JILL TARTER**
ASTRONOMER
▼ SELECTS
■ **MARGARET TURNBULL**
ASTROBIOLOGIST

Maggie Turnbull has made the most detailed census of our immediate solar neighbourhood to create a "finding" list for the son-of-terrestrial-planet-finder and the discontinued Darwin study. And she's trying a grand experiment in freelance astrobiology from the woods of Wisconsin.

● **ROBIN CHASE**
FOUNDER, BUZZCAR
▼ SELECTS
■ **ASH MAHESH**
SOCIAL TECHNOLOGIST

Ash Mahesh is an astronomer who changed career to address problems as diverse as traffic, public health and economic development. He combines business, politics, pragmatism and social vision in improbable ways and produces scalable results that he then puts into open source. If you ever think a problem is intractable, you just have to look at Ash's work to be inspired.

● **GRAEME LE SAUX**
BROADCASTER
▼ SELECTS
■ **VANESSA BERLOWITZ**
SERIES PRODUCER, BBC

Vanessa Berlowitz is responsible for programmes such as *Planet Earth* and *Frozen Planet*. Her commitment to using technology such as aerial and time-lapse photography have revolutionised the way we view and understand the natural world. She is shaping the thoughts of the viewing public, and by doing so motivating them to protect the natural environment.

● **NICHOLAS CHRISTAKIS**
SOCIAL SCIENTIST
▼ SELECTS
■ **DAVID G RAND** LECTURER, HARVARD BIOLOGY DEPT.

David is doing brilliant research in biosocial science, an area that promises to reshape how we see the world. He is investigating the origins of human co-operation and is spearheading efforts to invent new ways to research social science online. (Full disclosure: I have already had lunch with him in the past, but I'd welcome the chance to continue our conversation.)

● **CAROLYN PORCO**
PLANETARY SCIENTIST
▼ SELECTS
■ **SAM HARRIS** AUTHOR AND NEUROSCIENTIST

Harris's brave, full-throated criticism of God-belief, backed by an impressive knowledge of neuroscience, the contents of the "holy books", and the tenets of the world's religions and philosophies, have helped bring to the fore the irrationality of belief in a supreme being. He has made major waves in our thinking on this subject and there's no end in sight to his contributions.

ILLUSTRATION: LYNDON HAYES

● LILY COLE ACTRESS AND MODEL ▼ SELECTS ■ HAZEL HENDERSON FUTURIST AND EVOLUTIONARY ECONOMIST

I recently came across Hazel Henderson's work. She has been writing and speaking for many years about the practical, philosophical and political ramifications of our economic system, offering an intelligent critique of the rules of our peculiar game (the social and environmental consequences). She also posits that there are alternatives beyond our general – and somewhat blinkered – assumption that this is the only way. Her work seems especially pertinent in light of the global economic crises, and perhaps offers space for optimism concerning other possible ways.

● NANCY LUBLIN
CEO, DOSOMETHING.ORG
▼ SELECTS
■ **ADAM BRAUN** FOUNDER, PENCILS OF PROMISE

Pencils of Promise is a nonprofit which builds schools in Laos and Guatemala. It raises all its money online from kids in $25 (£16) increments. It's the official charity of Justin Bieber, but in the end Adam Braun will be the bigger rock star.

● NICHOLAS D KRISTOF
PULITZER PRIZE-WINNING JOURNALIST
▼ SELECTS
■ **CHEN GUANGCHENG**
HUMAN-RIGHTS ACTIVIST

I'd like lunch with Chen Guangcheng, an amazingly brave Chinese human-rights activist. A blind man who trained himself in law, he exposed a series of abuses and was jailed in retaliation. He served a four-year sentence, but China has kept him under extra-legal house arrest with no contact with the outside world. Security forces beat up those who approach his house, and reportedly tortured him when he smuggled out word of his situation. He's indomitable.

● RANDI ZUCKERBERG
INTERNET ENTREPRENEUR
▼ SELECTS
■ **TINA FEY** COMEDIAN

I'm inspired by Tina Fey – she is a great example of somebody who can be both an entertainer and a serious businesswoman, and has made a career out of pursuing her passions. She also balances being a mum, an entertainer and a media mogul with grace and poise.

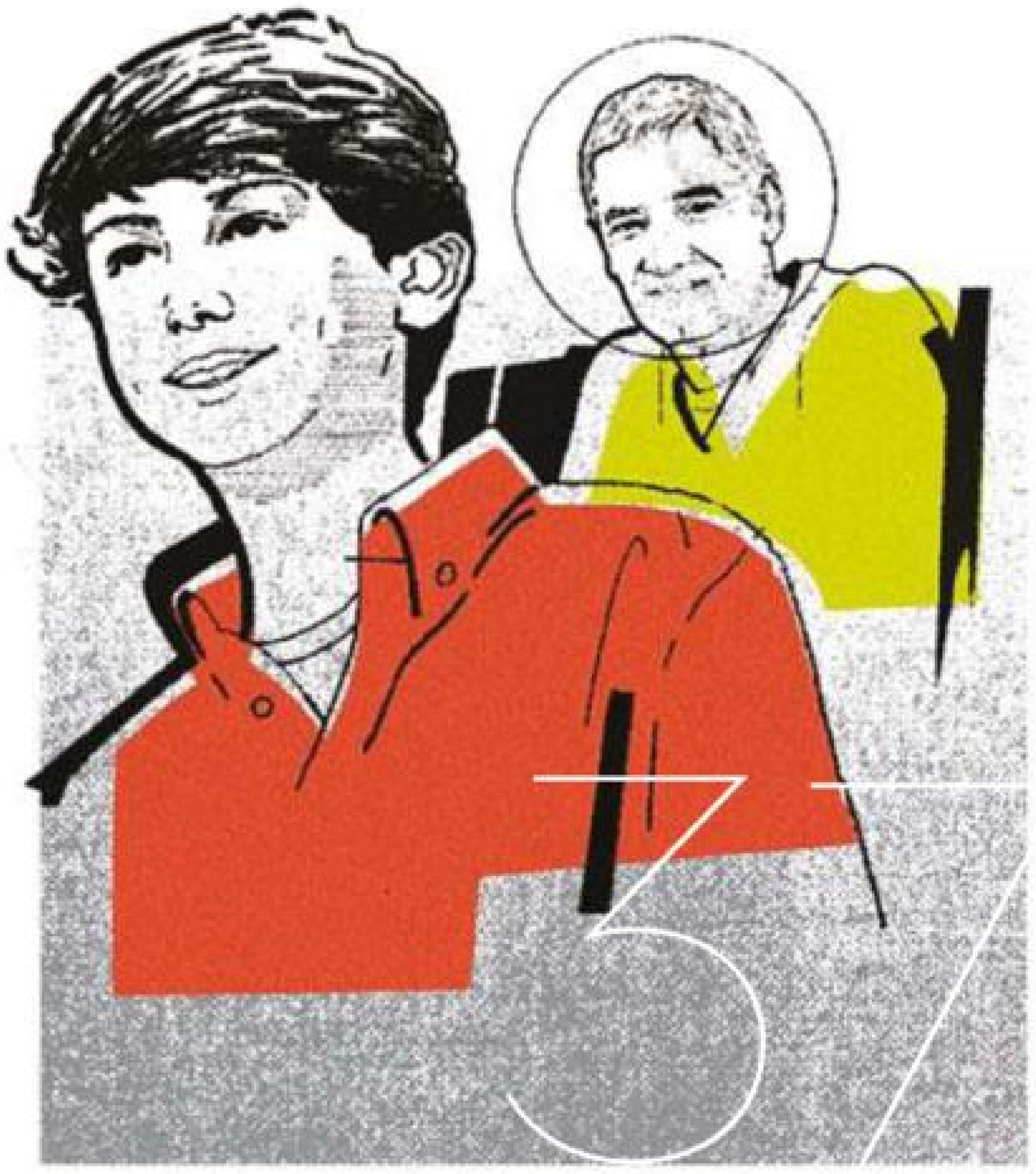
● AZA RASKIN
ENTREPRENEUR
▼ SELECTS
■ **TOM COATES**
TECHNOLOGIST

One of the earliest bloggers – he started in 1999 – Coates is a surly Englishman who has a rare mix of design ability and future-think. He's predicted and embodied the blog revolution, location services, and the internet of things. He will change the way we think about and understand cities.

● JAMES DYSON INVENTOR AND ENTREPRENEUR ▼ SELECTS ■ AIDAN DWYER SCIENTIST

Every designer has an enquiring mind. They observe the world around them and constantly ask themselves how to make it better. Nature is the ultimate engineer. While out walking in upstate New York, Aidan Dwyer, 13, became curious about why the tree tops tangle in a seemingly random way. His studies revealed that trees grow their branches in a pattern dictated by the Fibonacci Sequence: 1+1=2, 1+2=3, 2+3=5 and so on. He noticed that, even in nature, function guides form.

Aidan then challenged the boundaries of his learning. He took his scientific knowledge of photosynthesis and applied it to the problem of solar-energy collection. He built his own tree-inspired model of solar panels and tested it in his back garden. Hands-on investigation at its best. It was hailed as a breakthrough – then denounced by the media for little errors. To focus on failure here is to miss the point. Aidan was observant. He challenged the norm. He asked why. In the process this teenager made an entire industry stand up and take note. Inspiring. The only person who should focus on the failure is Aidan – it will lead him to better things. 🅆



WE G
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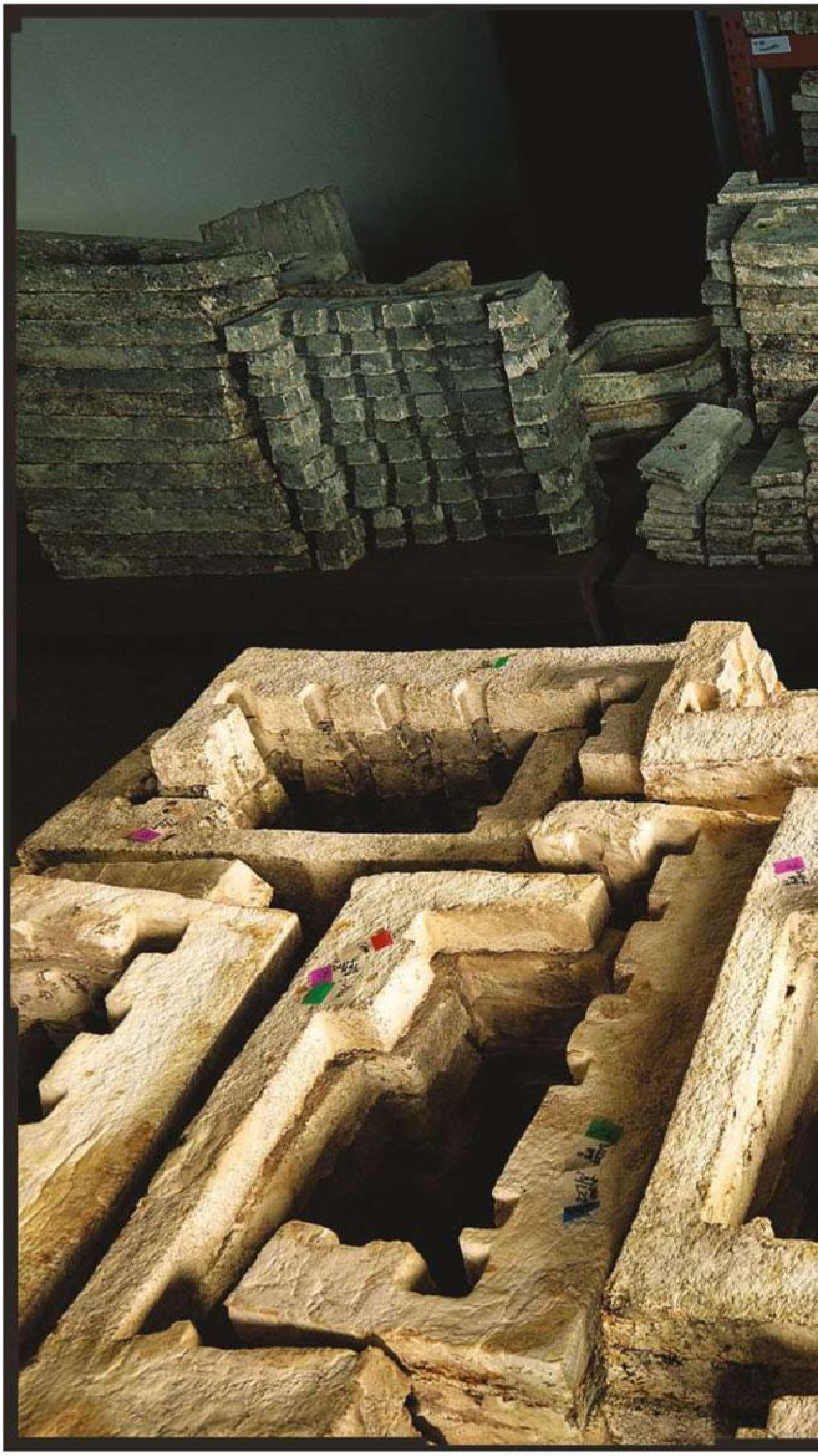
HEAD

OUT OF FUNGUS

THESE MEN AIM TO WIPE OUT THE POLYSTYRENE INDUSTRY. THEIR SECRET WEAPON: PACKAGING GROWN FROM FUNGUS AND FARM WASTE

BY CHRIS RAYMOND

PHOTOGRAPHY: Chris Crisman

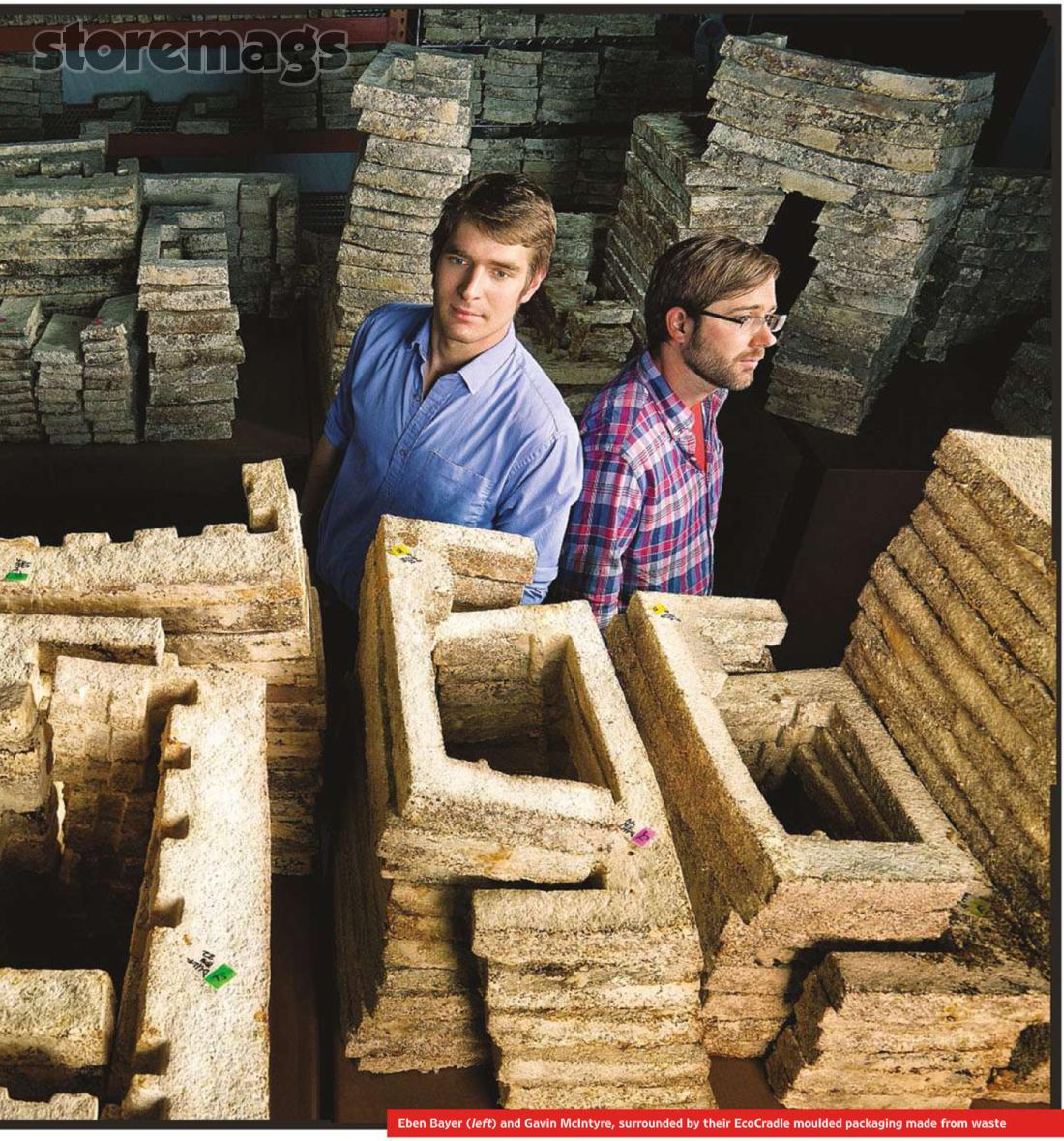


Eben Bayer is on a mission: he wants simply to eradicate the polystyrene packaging industry. The trouble with 1-phenylethane-1,2-diyl, as the resourceful 26-year-old entrepreneur from Vermont sees it, is that, as no known microorganism can biodegrade it, it pollutes the oceans and clutters landfills – making up around 30 per cent of US landfills alone, according to some estimates. In the 173 years since Eduard Simon first produced polystyrene, it has become a highly lucrative by-product of the oil industry, made using a liquid hydrocarbon derived from petroleum in a process that creates millions of tonnes a year. But Bayer has a plan to change all that.

His plan involves replacing polystyrene with mushrooms. By combining fungus with agricultural waste to create packaging that's cheap, durable and biodegradable, Bayer hopes to disrupt an environmentally destructive industry valued globally at around $20 billion (£13 billion). It's an enormous ambition, certainly – but his startup, Ecovative Design, has already made powerful friends. Honoured as a tech pioneer at the World Economic Forum in Davos, it has attracted millions in grant money from the US Environmental Protection Agency, the National Science Foundation and the US Department of Agriculture, plus private investment from the likes of 3M and RPI.

Bayer is not a typical psilocybin enthusiast. With his patrician good looks and tall, lean build, he could easily pass for a professional tennis player. He greets visitors with a hearty handshake. Ecovative is housed in a commercial complex overlooking the dilapidated grounds of the local power authority in the town of Green Island, 16km from the Rensselaer Polytechnic Institute campus in upstate New York, where he studied and founded the business four years ago.

It seems like a strange place for a startup, but it's appropriate: Ecovative has far more in common with its industrial-era neighbours – the red-brick Honeywell



Eben Bayer (*left*) and Gavin McIntyre, surrounded by their EcoCradle moulded packaging made from waste

factory down the road – than it does with the high-growth new businesses of Silicon Valley. What Bayer is proposing is a manufacturing business – a foam-packaging empire powered by mushroom spores.

Bayer likes to call polystyrene "the toxic white stuff". Standing at the first stage of Ecovative's production line, he points out that every 0.02 cubic metres of polystyrene requires a litre and a half of petroleum to manufacture. "This is where a huge vat of oil would be," he says, grinning.

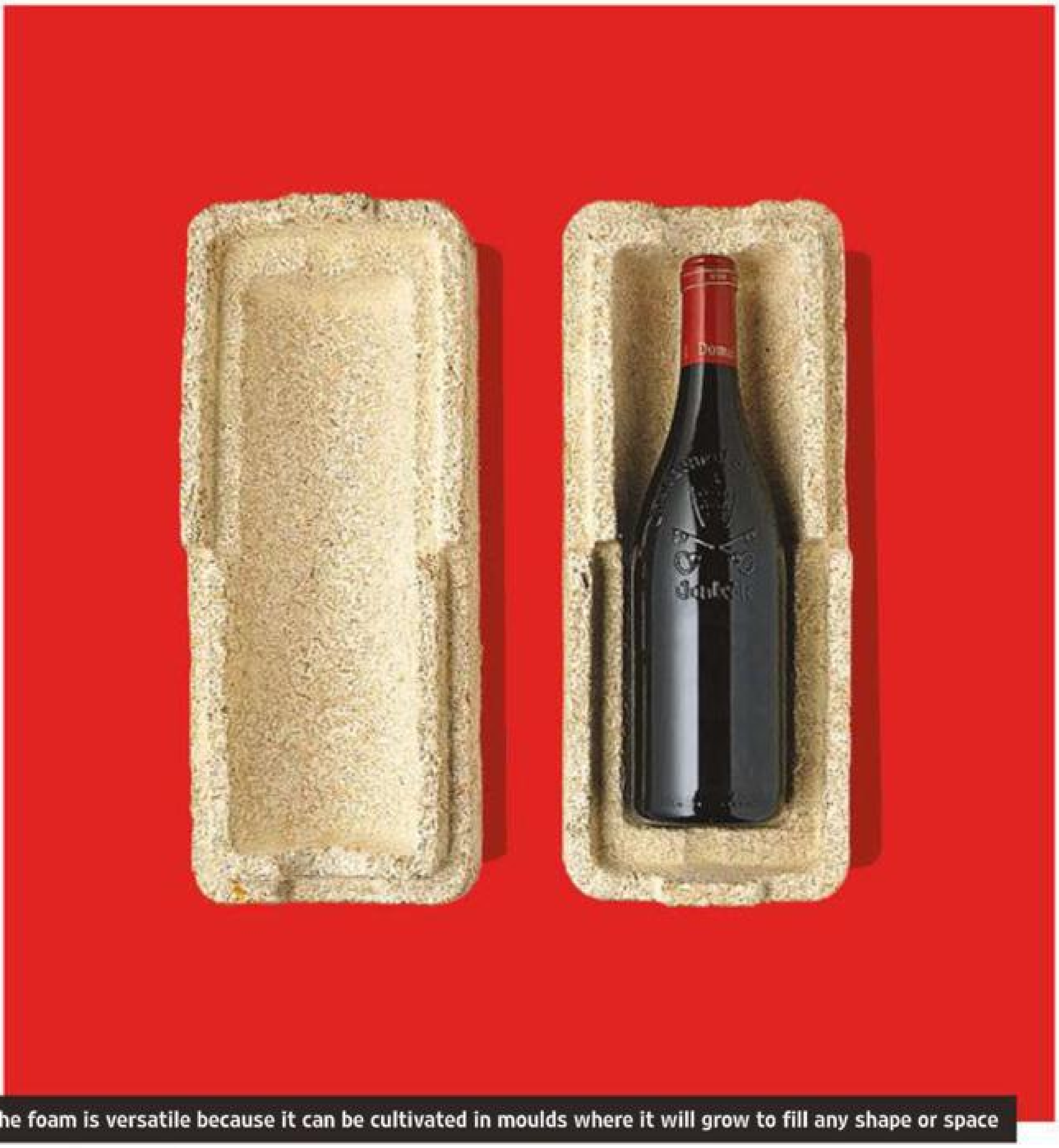
The Ecovative process begins instead with agricultural waste. The three stainless-steel hoppers towering in front of Bayer contain cotton burrs, rice hulls and buckwheat hulls – post-harvest chaff. The straw-coloured material is released on to a conveyer belt, which channels it through a steam cleaner to eliminate mould, bacteria and insects. The mixture is then impregnated with spores of mycelium, the thread-like vegetative part of fungus. Two women in hospital gowns and rubber gloves, heads shrouded in sterile caps, catch the bristly stew in plastic moulds. At this point, the moulds resemble the foam caps used to cushion computer servers in transit. Other versions mimic the cocoons used to safeguard bottles of wine or the corner braces of office furniture.

They're then placed in steel racks similar to those found at a bakery. This is where the mycelium starts to work. "It excretes compounds into the agricultural waste – that's how it breaks down cellulose," Bayer explains. "It pulls in the cellulose, digests it and turns it into a polymer. What we do is use the organism as glue; a living glue that grows into every nook and cranny."

Over the next five days, as the mixture steeps, the mycelium will consume most of the organic material, or substrate, enveloping the leftovers in tiny filaments a fraction of the width of a human hair. When popped from the mould, the product looks like a chunk of white chocolate with almond flecks inside it. It's soft to the touch, like a mushroom, but exceptionally sturdy. By altering the substrate mixture, Gavin McIntyre – the company's chief scientist and Bayer's business partner – can adjust the strength and flexibility of the foam. More cotton burrs increase the thermal dynamic, more rice hulls makes it more fire-retardant. "You can hit it with a blowtorch," McIntyre says. "And it doesn't burn."

Each cubic centimetre of EcoCradle foam contains some 4.8km of mycelium fibre, all created without a single unit of energy. "This organism is not a picky eater," says Bayer. "We can use almost any lignose-cellulosic waste as a substrate." That includes sawdust, hemp core, paper pulp, even lobster shells.

This is the advantage of the company's product, EcoCradle: it does not require fossil fuels to manufacture and it's fully compostable. When it arrives on your doorstep, you simply throw it on the garden. Within 90 days, it's biodegraded. "If you look at a piece of Styrofoam [polystyrene]," says McIntyre, "it's derived from a resource that's been in the earth for 65 million years. If you look at a piece of cardboard, it comes from a tree that grew for seven or eight years before it could be sustainably harvested. We're taking waste and growing a fungus around it in five to seven days. From raw material to finished product," Bayer adds, "we're faster than anyone else in the world."



The foam is versatile because it can be cultivated in moulds where it will grow to fill any shape or space

Like many a Vermont boy, Bayer spent his childhood winters drilling holes in the trees near his family's maple-syrup farm. "Thousands and thousands of holes," he says. It was there in the forest that he first encountered the fungus called mycelium. "You kick over a log and there's this white stretchy stuff holding the leaves together," he explains. "I didn't think anything of it at the time, but later in college I was thinking of ways to make adhesives and it came back to me."

Bayer was slogging his way through a senior-level engineering course. His instructor was emphatically unimpressed with his class project – a wind turbine with no movable parts. In a fit of pique, Bayer tossed out another option. What if you could coax tiny filaments of mycelium into knitting a panel of foam insulation, the kind you tuck into the walls of your home? The professor paused to consider the possibilities. He was intrigued – so much so that Bayer re-enrolled in his course the following term.

Bayer enlisted the help of McIntyre, a fellow student who consumed biology books with the same zeal with which he devoured science fiction. The two had studied together for four years. They shared similar backgrounds. McIntyre grew up on Long Island, in the tiny town of Yaphank. His mother was a biologist and his father a mechanical engineer. Both men loved to hike.

McIntyre offered to grow the first foam samples in his university accommodation using psilocybin spores bought online. "We'd take perlite and mineral oil and wheat bran and mix them up on the stove," Bayer says. "We'd put them into moulds and impregnate them with fungus we bought off the internet. We'd put them under Gavin's bed and they'd grow – usually things we didn't want, but occasionally we'd get something interesting."

The two worked away on the project for months. When they graduated in May 2007 with dual degrees in mechanical engineering and product design, their professor pushed them to keep on working. "He was the one who got Gavin and me to take the next step with it," Bayer says. "Otherwise I probably never would have moved forward." Saddled with student loans and no income, the graduates moved the operation into a business incubator on the RPI campus. For $500 a month, they were given a workspace in an old classroom building. At night, they'd roam the halls exploring. They discovered a photographic space in the basement and annexed the darkroom. It had a sink and a ventilator hood. This became their first R & D lab.

After taking a five-day course on how to start a company, the nascent entrepreneurs drew up a business plan that won a green challenge competition at Oxford University. They used the £10,000 prize to start testing their foam panels. The results were encouraging: the material was waterproof, fire-retardant and had an R2 thermal rating (comparable to fibreglass insulation). It was also 100 per cent biodegradable.

This last part wasn't a big plus for building materials, but Bayer and McIntyre saw an opportunity to change direction. It was a huge selling point for packaging.

BAYER LIKES TO CALL POLYSTYRENE 'THE TOXIC WHITE STUFF'

Foam polystyrene was first produced commercially by chemist Ray McIntire in 1937, when household goods arrived on doorsteps packed in straw or sawdust. Because of its buoyancy, the new plastic was originally adopted by the US Coast Guard for use in the construction of rafts. But little by little, McIntire's employer, the Dow Chemical Company, found a whole range of applications for it. In 1954, polystyrene began to be used for insulating homes and packaging goods.

In 1950, companies worldwide produced 1.7 million tons of plastics. By 2010, that had climbed to 260 million. But with it came vast waste. After exposure to the elements and transport, that plastic – polystyrene included – breaks down into little pellets that make their way into the water system, and are transported to the sea. Traces of the material have been found inside zooplankton, mussels, barnacles, fish, seabirds and whales in every ocean in the world. Filmmaker Rebecca Hosking uncovered them in albatross chicks on Midway Island – 4,500km west of California and 3,540km east of Japan. The polystyrene that enters homes in meat trays, takeaway containers, coffee cups and egg cartons breaks down, but it never goes away. Every particle ever created exists somewhere on the planet.

When Belgian chemist Leo Baekeland invented Bakelite plastic in 1909, he was looking to create a synthetic polymer that resembled the shellac secreted by the Asian beetle. Bayer and McIntyre could not be more disdainful of that approach. The two

Ecovative employee Greg Vaughn pushes a rack of moulded EcoCradle components ready for assembly have spent a lifetime admiring nature and wondering how its methods might be applied to improve technology. On the way to lunch in McIntyre's blue Subaru, Bayer launches into a discussion on the globe's limited water resources. He begins by praising the ingenuity of trees in Africa with root structures that bore 122 metres into the continent's parched soil. Their leaves release water, he explains. If you could find a way to harvest the dew, you could transform the lives of millions of poor people.

This prompts McIntyre into a glowing account of the water-filtration system developed by the sand dollar, a burrowing echinoid related to the sea urchin. In a cubby beneath his dashboard sits a handful of seashells. When asked if they are keepsakes or research materials, McIntyre nods towards one encrusted with barnacles. "That's a very strong bond they've created," he says.

ECOVATIVE'S AMBITION IS TO DISRUPT A DESTRUCTIVE INDUSTRY

In essence, the duo's philosophy can be summed up as follows: why create synthetic substitutes when, over billions of years, nature has evolved viable iterations? This worldview was shaped by their years at RPI, where the engineering class has a rigorous philanthropic component. "The whole point was to develop a patentable technology that will have a significant positive impact on the world – it could be social, it could be environmental," Bayer says. Called "Inventor's Studio", the course is still taught by inventor and entrepreneur Burt Swersey.

Before joining the RPI, Swersey, a Cornell graduate, worked for 26 years inventing and refining metabolic scales for the medical industry. Along the way, he founded four companies. When he retired in 1988 at 52, he had more than 15 patents to his name. He devoted the next two decades to instructing college students on the principles of entrepreneurship and creativity. Inventor's Studio challenged students to find overlooked problems to solve.

"People weren't designing new cellphone covers," says McIntyre. "We were designing products that had applications in the Third World. Quite a few companies that came out of that programme are non-profit. They're not working on the next-generation flat-screen TV. They're working on an inexpensive wind turbine that can be constructed from garbage."

Ecovative's founders want to create a high-growth business that's profitable – but on an industrial scale. "We want to be the world leader in sustainable materials – just like Dow or DuPont were last century's leader in environmentally damaging synthetic materials," Bayer says. "We want to get rid of plastics in disposable applications."

Displayed in the steel warehouse that is Ecovative's headquarters is a horseshoe crab shell on a shelf and a surfboard made from EcoCradle foam. McIntyre's pet chinchilla, Audrey, scoots around the reception area tucked inside a clear plastic ball. Bayer and McIntyre's team includes a beekeeper, an architect and a winemaker. Mycologist Sue Van Hook came from California to join their efforts, and experts at have been generous with advice.

"We've been pretty lucky at cold-calling some high-level people," says McIntyre. When he and Bayer needed hard data to verify their claims, for example, the director of the fire research laboratory at the National Institute for Science and Technology in Gaithersburg, Maryland, made them an offer, as a startup, they couldn't refuse. "If you come down here," he said, "we'll show you how to use the equipment and you can test it yourselves."

Ecovative now produces roughly 10,000 units of EcoCradle foam per week, nearly all for Dell and office-furniture manufacturer Steelcase. Unlike a Silicon Valley software business, the company can't extend its reach simply by doubling its server capacity.

HOW TO GROW YOUR OWN

How Ecovative takes its mycelium-based packaging from raw material to finished product in five to seven days

Ecovative aims to be green from the start. Every 0.02 cubic metres of polystyrene requires a litre and a half of petroleum to create. The Ecovative process begins with agricultural leftovers.

Chaff – cotton, rice and buckwheat husks – are sent through a steam cleaner. Adjustments to the mixture alter the flexibility, strength and fire-retardant character of the resulting product.

The mixture is then infused with spores of mycelium, the thread-like vegetative component of fungus. The resulting stew is put in moulds according to the shape required by the client.

The moulds are placed in steel racks. The mycelium excretes compounds that break down cellulose and turn it into a polymer, acting as a living glue that grows into every crevice.

Over the next five days the mycelium will consume most of the organic material, or substrate, enfolding the plant waste in tiny filaments that are a fraction of the width of a human hair.

The foam is taken from the mould. It is soft but very sturdy. Each cubic centimetre contains 4.8km of mycelium fibre, all created without a single unit of energy.

ILLUSTRATION: KYLE TEZAK

To open new markets, Ecovative must have facilities throughout the US. To expand overseas, it needs people in China, where most of the products that require packaging are made. The promise of manufacturing jobs has an irresistible appeal to politicians, and Ecovative's R&D lab has received more than $4 million in grant money from US state and federal sources. Bayer has also been hailed for his message: he was invited to speak at TEDGlobal in Oxford in July 2010. It's not enough, though, to impress scientists, politicians and thought leaders. To succeed, Ecovative will have to convert industry sceptics – the people charged with getting goods to the public in perfect condition. "The material they're producing can't be sold as just a sustainable substitute," Swersey says. "It has to be even better than Styrofoam."

Multinationals are buzzing with sustainability initiatives. U-Haul claims to have diverted more than 170,000 cubic metres of polystyrene from landfills by switching to peanut packaging made from corn and potato starch. Walmart encourages suppliers to create greener packaging by employing an online scorecard that evaluates some 627,000 items sold in its stores. Pepsi plans to unveil a new bottle in 2012 whose manufacture requires no petroleum: instead, the plastic is fashioned from sugars stored in switch grass, pine bark and corn husks. Ford is hoping to replace 14kg of petrol-based material in each car. It has already adopted soy-based seat cushions, and is now experimenting with resins produced from algae, wheat straw and chicken feathers. The company's plastics research team is also considering Ecovative's mushroom foam for use in bumpers, dashboards and side doors.

Bayer and McIntyre in one of the company's clean rooms with some of their foam's raw materials

"Industry has thought of Styrofoam as one of those workhorses you couldn't replace, much as they once thought of chlorofluorocarbons," says Joel Makower of the GreenBiz Group consultancy. "Nobody likes Styrofoam. You can't do anything with it at the back end, except maybe break it down into something that can be remoulded, but the options aren't attractive. Now you have something that goes into the soil and becomes a nutrient. That's the cradle-to-cradle dream."

Steelcase's logistics manager Dennis Carlson approached Ecovative in summer 2009. He'd searched for alternatives to polystyrene, but had found little on the market that was cost-effective, and was concerned that most products' green credentials were questionable: if the petroleum wasn't in the packaging, it was used to collect the materials from faraway lands.

After months of testing and refining, Steelcase started using Ecovative's EcoCradle packaging in June 2010. Many of the company's products now arrive in Europe, Canada, Mexico, China, Japan, Malaysia and Saudi Arabia packed in mycelium fibre. It takes a little extra paperwork to convince each new market that the material is parasite-free, says Carlson; but Bayer has been able to convince potential new partners of Ecovative's production process right down to the industrial ovens that halt the mycelium's growth. EcoCradle costs no more than Styrofoam. And with increased automation, more volume and additional efficiencies in shipping, it is likely to grow less expensive.

Ecovative achieved a modest $500,000 in sales in 2010, but the company recently received Series B financing from 3M, RPI and the Dutch Doen Foundation. This year, it will expand into a 929-square-metre space in the Albany area, where Bayer plans to build a model facility almost entirely out of off-the-shelf equipment. The production line will be able to produce 120,000 parts per week. The goal is to show that the technology is easily transferable anywhere in the world.

For Bayer, the $20 billion polystyrene business is just the start. "There's hundreds of billions of dollars in expanded foams," he says. "Even more if you start to look at plastic films. Plastic is all around us."

Chris Raymond is a freelance writer and editor

ROBOT SEE, ROBOT DO: INSIDE THE AUTONOMOUS ANDROID LAB

BY
RAFFAELE ORIANI

PHOTOGRAPHY:
GIOVANNI TROILO

The Italian Institute of Technology in Genoa is an incubator of intelligence, artificial and otherwise. Its army of 900 scientists from 37 countries is working towards a single goal: robots that can learn to think for themselves

NAME
ROBERTO CINGOLANI

JOB TITLE
DIRECTOR, ITALIAN INSTITUTE OF TECHNOLOGY

PROJECT
iCUB

FUNCTION
iCUB IS AN OPEN-SOURCE HUMANOID ROBOT TESTBED FOR ARTIFICIAL-INTELLIGENCE RESEARCH. MORE THAN 20 LABORATORIES WORLDWIDE ARE USING AN iCUB FOR ROBOTIC COGNITION RESEARCH

On the outskirts of Genoa, the Italian Institute of Technology (IIT) is home to numerous disciplines geared toward bringing artificial intelligence into the real world. A research skunkworks with an annual budget of €100 million (£87m), the IIT explores robot forms of every kind: bipeds, quadrupeds, torso-less legs capable of gymnastics, and iCub (*left*), a baby-faced humanoid which is central to the institute's studies. Researchers have taught it to crawl, recognise objects, pick them up, move them – and not to break them.

"To live among us, robots will have to be very different from how they are now," says Roberto Cingolani (*above*), the institute's director. Here are just a few of the scientists involved, and how their specialist fields will take robotics out of the lab and into our lives.

NAME

DARWIN
CALDWELL

JOB TITLE

DIRECTOR,
ADVANCED ROBOTICS
DEPARTMENT

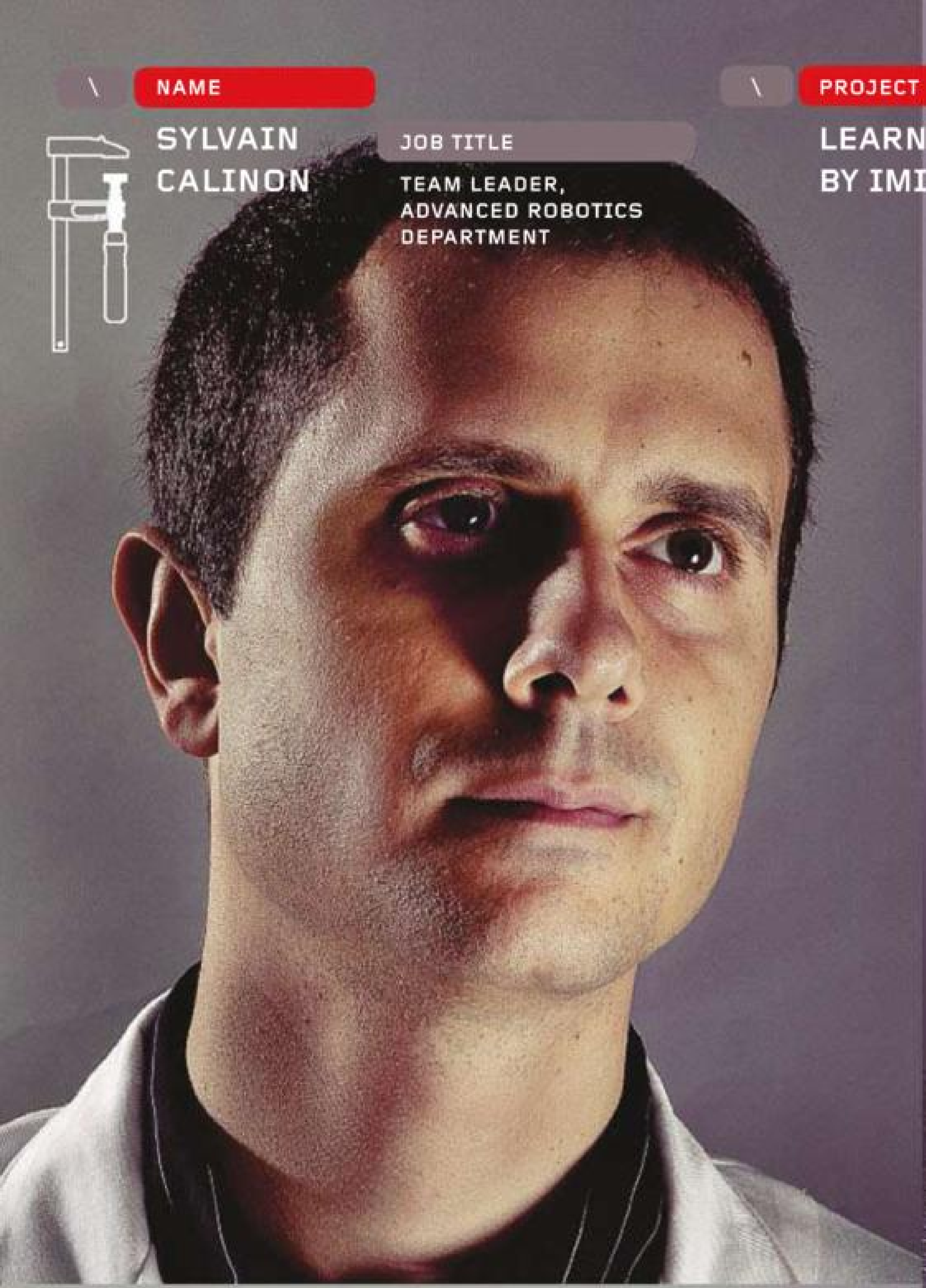
PROJECT

"COMPLIANT"
COMAN

FUNCTION

THE GAIT OF THESE WALKING ROBOT LEGS EMULATES THAT OF A HUMAN, INCLUDING TILTING THE PELVIS BETWEEN STEPS TO INCREASE STABILITY

iit
iit
MICREL
Pulse

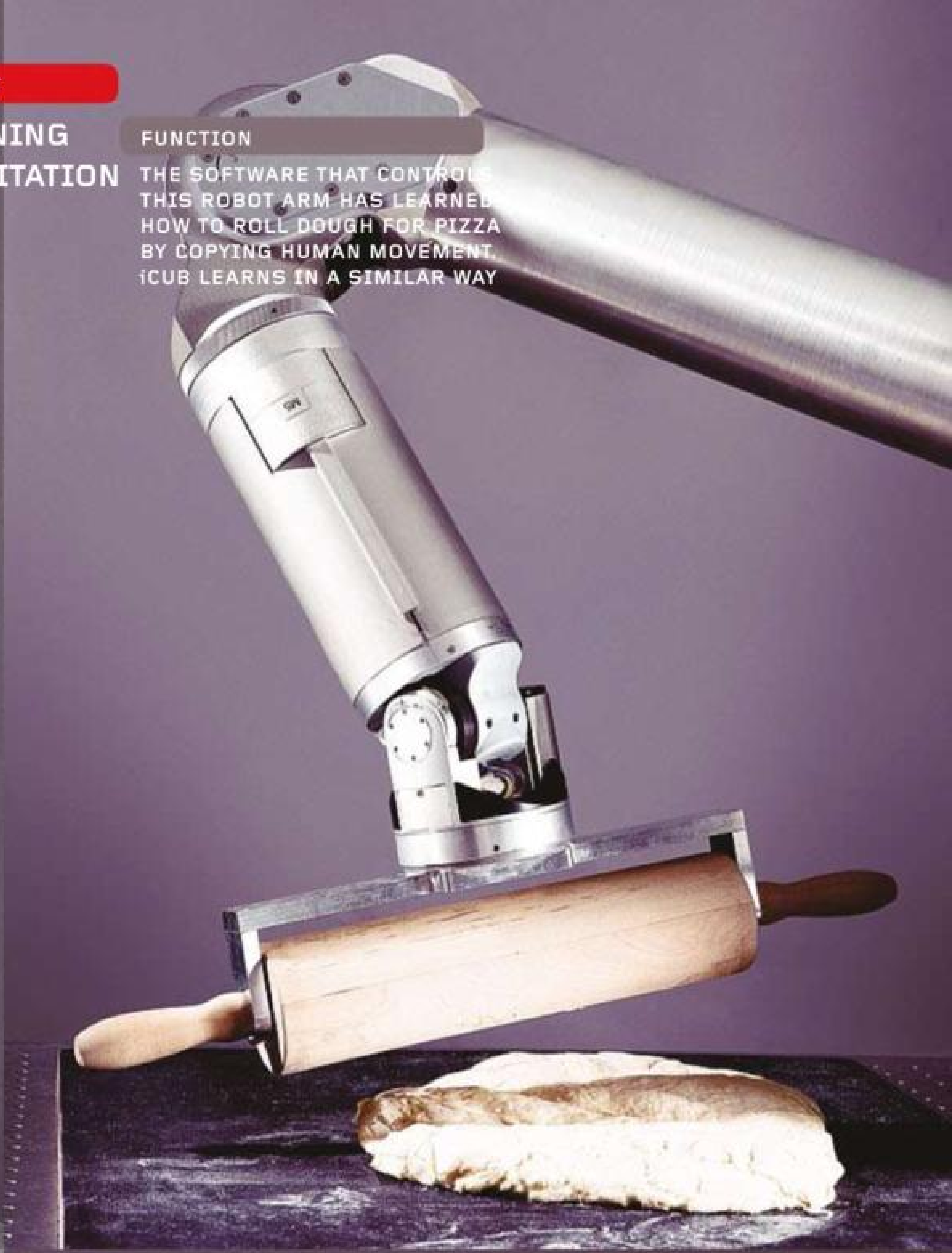


NAME

SYLVAIN CALINON

JOB TITLE

TEAM LEADER, ADVANCED ROBOTICS DEPARTMENT

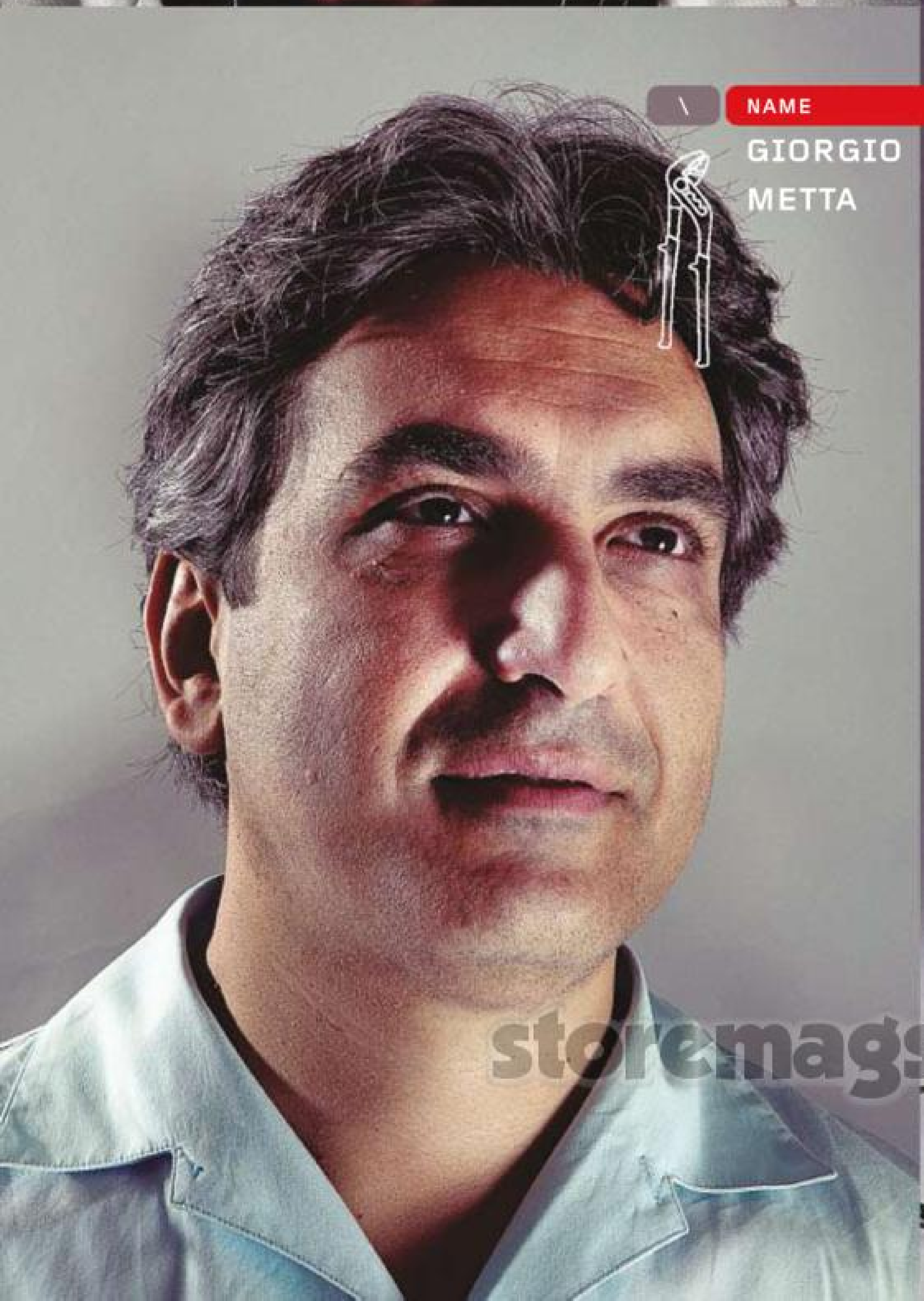


PROJECT

LEARNING BY IMITATION

FUNCTION

THE SOFTWARE THAT CONTROLS THIS ROBOT ARM HAS LEARNED HOW TO ROLL DOUGH FOR PIZZA BY COPYING HUMAN MOVEMENT. iCUB LEARNS IN A SIMILAR WAY

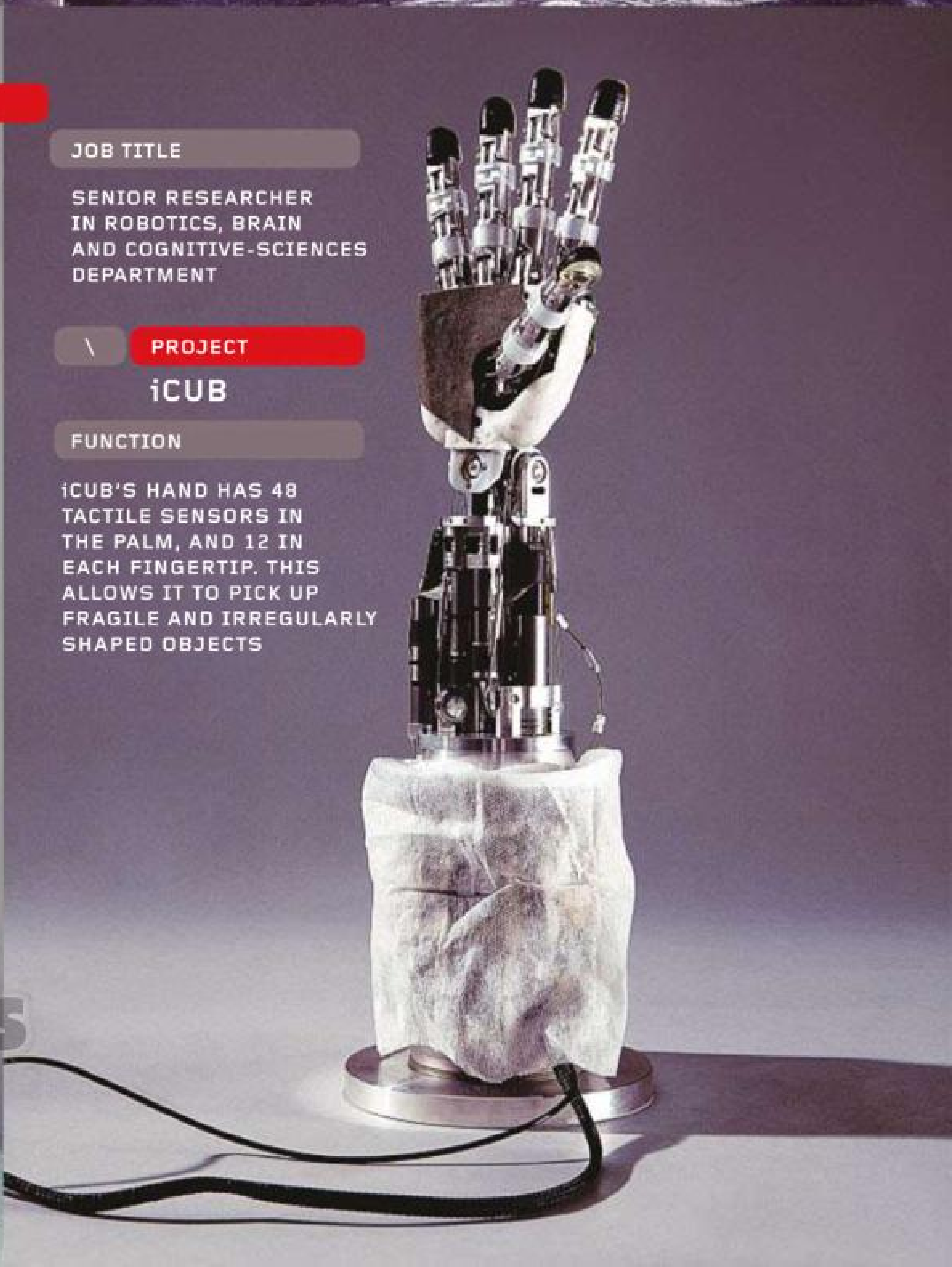


NAME

GIORGIO METTA

JOB TITLE

SENIOR RESEARCHER IN ROBOTICS, BRAIN AND COGNITIVE-SCIENCES DEPARTMENT

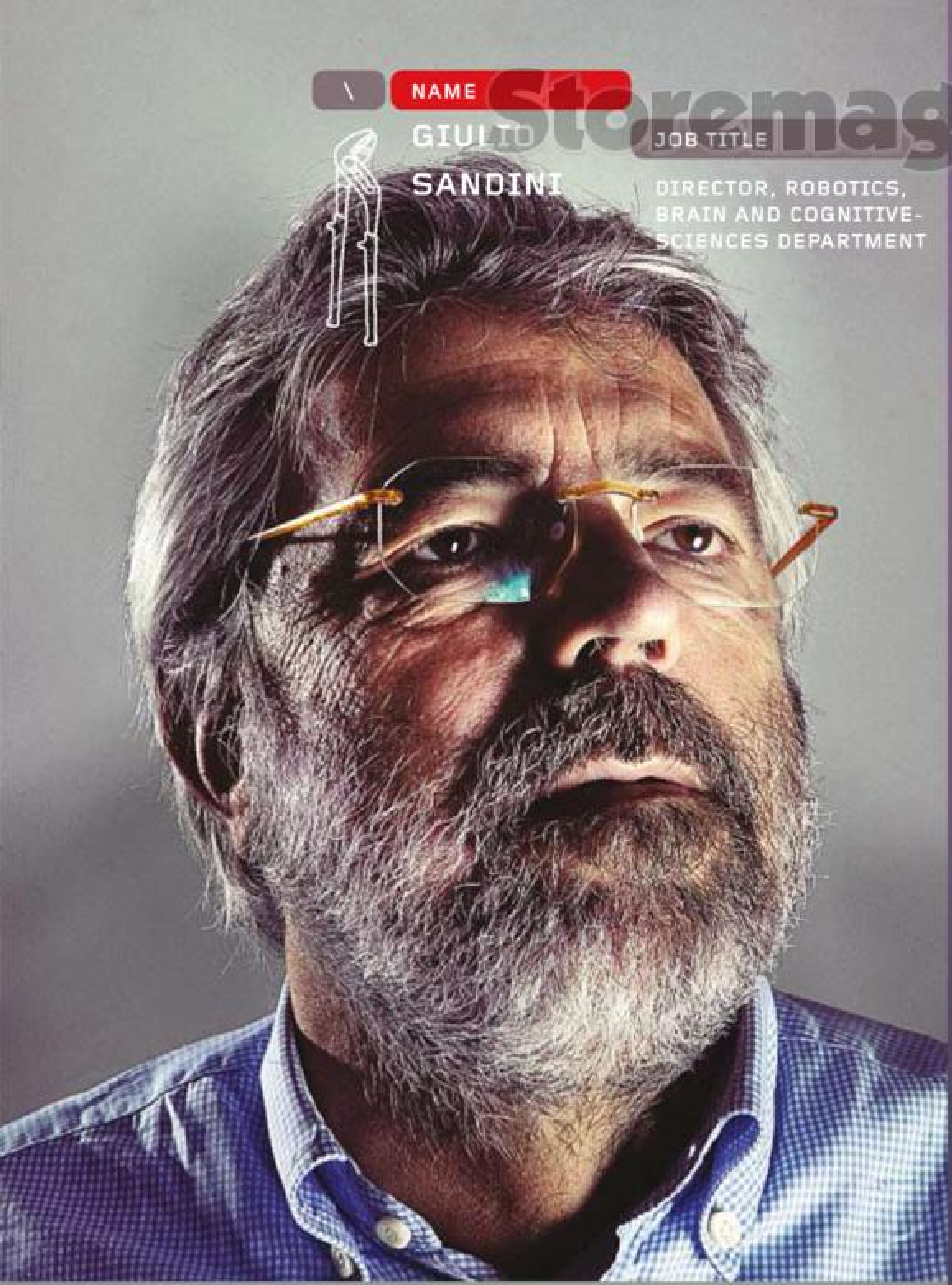


PROJECT

iCUB

FUNCTION

iCUB'S HAND HAS 48 TACTILE SENSORS IN THE PALM, AND 12 IN EACH FINGERTIP. THIS ALLOWS IT TO PICK UP FRAGILE AND IRREGULARLY SHAPED OBJECTS



NAME

GIULIO SANDINI

JOB TITLE

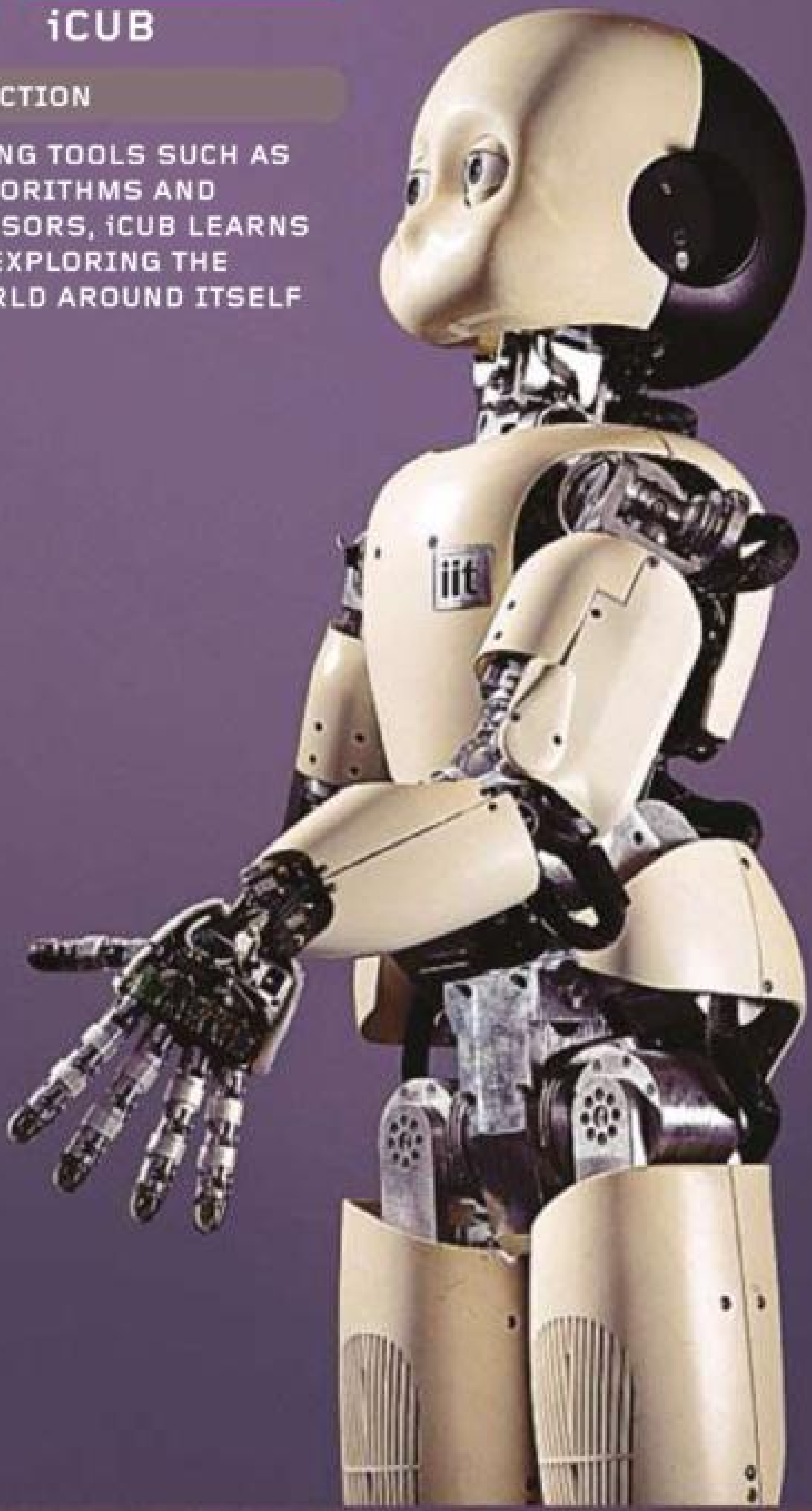
DIRECTOR, ROBOTICS, BRAIN AND COGNITIVE-SCIENCES DEPARTMENT

PROJECT

iCUB

FUNCTION

USING TOOLS SUCH AS ALGORITHMS AND SENSORS, iCUB LEARNS BY EXPLORING THE WORLD AROUND ITSELF



NAME

CHIARA BARTOLOZZI

JOB TITLE

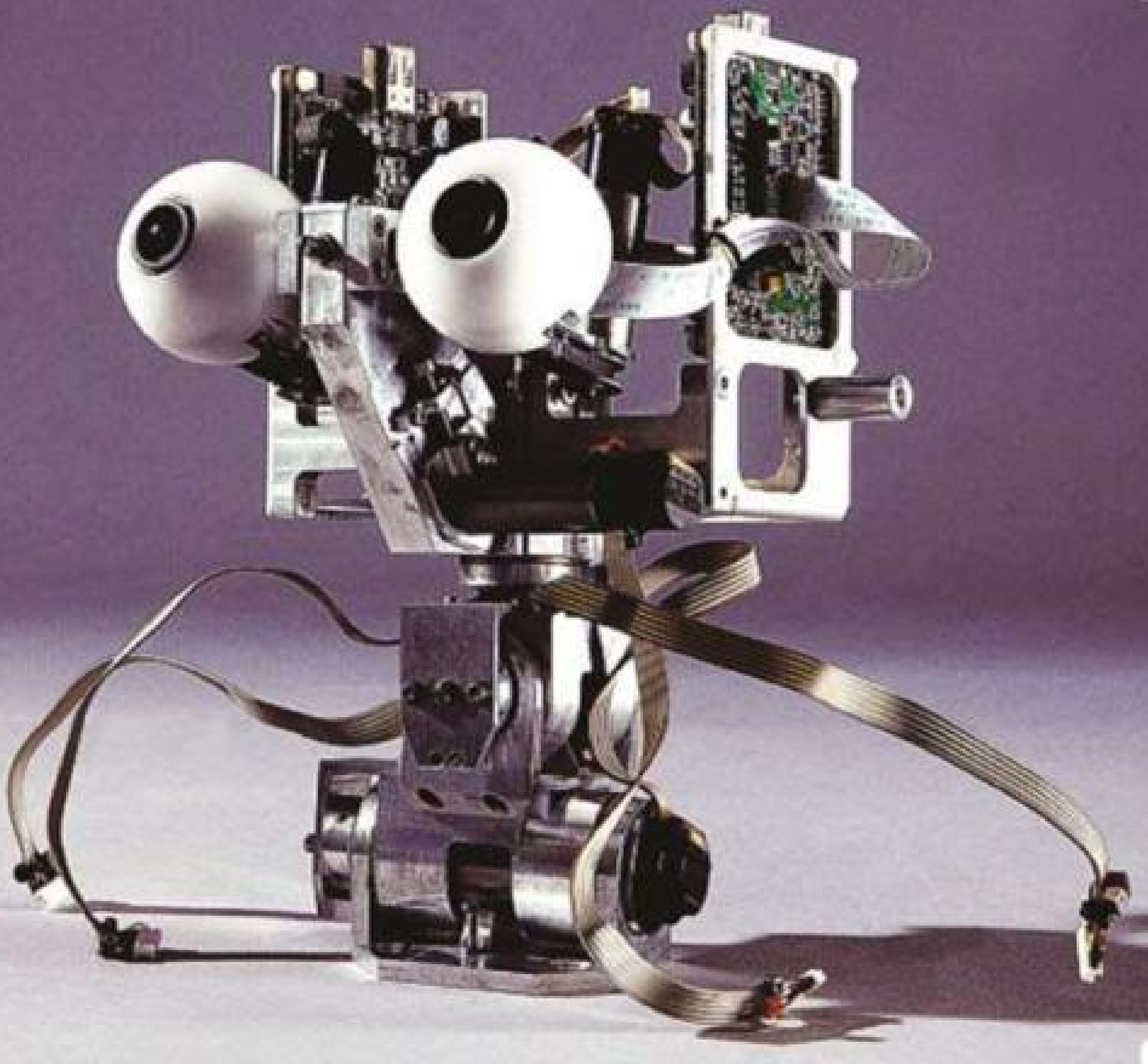
POST-DOCTORAL RESEARCHER IN ROBOTICS, BRAIN AND COGNITIVE-SCIENCES DEPARTMENT

PROJECT

iCUB

FUNCTION

ITS HEAD COMPONENTS AND VISION SYSTEMS ENABLE iCUB TO SEE IN STEREO 3D AND IDENTIFY NUMEROUS OBJECTS ◼



CROWD CONTROL

Forget anarchy. Today's protests, revolts and riots are self-organising, hyper-networked – and heading for a city near you. **Bill Wasik**, credited with inventing the flash mob nine years ago, reports

Illustration: **WK INTERACT**

RIOT

LET'S START WITH THE FUNDAMENTAL PARADOX: OUR PERSONAL TECHNOLOGY IN THE 21ST CENTURY – OUR LAPTOPS AND SMARTPHONES, BROWSERS AND APPS – DOES EVERYTHING IT CAN TO KEEP US OUT OF CROWDS.

Why pack into your city-centre department stores when Amazon can speed the essentials of life to your door without your having to negotiate crowded pavements and stand in queues? Why approach strangers at parties or bars when dating sites such as mysinglefriend.com can more efficiently shuttle potential mates into your bed? Why sit in a cinema when you can stream? Why cram into arena seats when you can pay per view from your sofa? We declare the obsolescence of "bricks and mortar", but let's be honest: what we usually want to avoid is the flesh and blood, the unpleasant waits and stares and sweat entailed in vying against other bodies in the same place, at the same time, in pursuit of the same resources.

And yet, on those rare occasions when we want to form a crowd, our technology can work a strange, dark magic. Consider this note, passed around among young residents of Greater London on a Sunday in August last year:

Everyone in edmonton enfield woodgreen everywhere in north link up at enfield town station 4 o clock sharp!!!!

Bring some bags, the note went on; *bring cars and vans, and also hammers. Make sure no snitch boys get dis*, it implored. *Link up and cause havic, just rob everything. Police can't stop it*. This note, and variants on it, circulated on August 7, the day after a riot had broken out in Tottenham, protesting against the police killing of 29-year-old Mark Duggan in a botched arrest. So the recipients of this missive, many of them at least, were already primed for violence.

It helped, too, that the medium was BlackBerry Messenger (BBM), a private system in which "broadcasting" messages – sending them to one's entire address book – can be done for free, with a single command. Young people in the UK have embraced the platform wholeheartedly, with 37 per cent of 16- to 24-year-olds using the devices nationwide; the percentage is probably much higher in urban areas like London. From early on in the rioting, BBM messages were pinging around among the participants and their friends, who were using the service for everything from sharing photos to co-ordinating locations. Contemplating the corporate-grade security and mass communication of the platform, Mike Butcher, editor of TechCruch Europe and a digital adviser to London Mayor Boris Johnson, wryly remarked that BBM had become the "thug's Gutenberg press".

Nick de Bois, one of Enfield's representatives in Parliament, was whiling away that Sunday afternoon at the horse races in Windsor, where a friend's wife was celebrating her 40th birthday. It was a fine day of racing: in the third, Toffee Tart bested Marygold by just half a length, paying off at 7/2. "Unusually for me, I hadn't looked at my handheld in two hours," de Bois says. But when he did look, he saw something disturbing. Gossip was swirling about more riots that night, with Enfield named as a likely target.

De Bois decided he had better cut his race day short. "I never even had a chance to recover my losses," he deadpans.

By five in the afternoon, he was on the streets of Enfield Town, along with a handful of police. Was there a riot? No – not really, not yet. But there was a gathering crowd, a mixed-race group of mostly young men, just milling around in small bunches. Some were conducting what de Bois describes as "reckies" – reconnaissance missions – around the town centre. "They were just having a good look," he says.

Then, at around 6pm, as if at some unvoiced, unseen command, the street exploded. The crowd hit a Pearsons department store, a Starbucks, an HMV. Police were able to move in and contain the violence – or so they thought – to a small part of the town's shopping district. "Of course, there were side roads," de Bois says. "But broadly speaking, the looting had been contained. Calm had been restored." It was a loose version of kettling, an anti-riot tactic whereby police keep a disorderly crowd penned in, often for hours, to avoid their causing any more trouble.

Only then, though, did the situation in Enfield get truly surreal. De Bois was standing outside the sealed-off zone, behind one line of police, in an open area that led to the train station. As he watched in amazement, more and more people – some disembarking trains at the station, some stepping out of cars – continued to pour into the shopping centre. Riot police were convoying in, too, but their numbers couldn't possibly keep up. And even if they did, it was impossible definitively to separate the would-be rioters from the bystanders.

Right behind a line of armour-clad police who had successfully contained a riot, this new crowd of hundreds was gearing up to start off a second one. As 7pm approached, face coverings went up, and a small group walked past de Bois with a crowbar. Gangs began to break windows throughout the centre – one local jewellery store lost nearly £40,000 in stock. Police would descend on a group, but then the crowd would disperse, only to reconstitute itself somewhere else a few minutes later.

But there was also something strange about the character of this riot, and these rioters – something that seemed to make the violence unstoppable. At base, it was their confidence: their surety that, as they streamed out of their cars and trains, or as they milled around in small groups, or even after they were dispersed by police, they would always find one another in sufficient numbers. As de Bois wandered through the crowd, he buttonholed one of the young men, asked him who they all were and why they were there. "Don't worry," said the looter to the MP, in a tone of gruff reassurance. "We'll be out of here soon."

PHOTOGRAPHY: GETTY; REX

Riot police apprehend a youth after violence breaks out in Enfield Town on August 7, 2011

The year 2011 brought waves of crowd unrest not seen on a worldwide scale for more than three decades. From January's revolutions in Egypt and Tunisia through a summer of sit-ins and demonstrations in Europe, India and Israel to the Occupy Wall Street movement in autumn, in the past year a new generation of activists has rediscovered – and subtly reinvented, through social media – street action as a means of political expression.

But on both sides of the Atlantic, there was a rash of more mysterious, more malicious-seeming crowds in which technology appeared to play a central role. Riots spread across Britain over four days and caused millions of pounds worth of property damage. US cities struggled with their own disorder: in Kansas City, Missouri, gunfire injured three after hundreds of high-school students descended on an open-air shopping mall, while Philadelphia imposed a curfew to fight a long string of surprise gatherings by teens. At least five cities experienced an innovative form of robbery, whereby a large group of kids would simultaneously run into a store, take items off the shelves, and run out again. To be sure, technology wasn't at the root of all the crowd mayhem: for example, an investigation of a group robbery in Germantown, Maryland, determined that the thieves had hatched their plan on a bus, not online. But with most of these events, there was some sort of electronic trail (Facebook, Twitter, texts, BBM) that showed how they coalesced.

Groping for what to call these events, the media christened them "flash mobs" – lumped them in, that is, with the fad in which large crowds carry out a public performance and then post the results on YouTube. So at around the same time that Fox was running a lighthearted flash-mob reality show called Mobbed, and *Friends With Benefits*, the high-grossing rom-com starring Justin Timberlake and Mila Kunis, featured a flash-mob dance in Times Square, New York, US pundits and public officials suddenly began railing against flash mobs as a threat to public order. Petrol station robberies became "flash-mob robberies", or even "flash robs". "THE EVOLUTION OF FLASH MOBS FROM PRANKS TO CRIME AND REVOLUTION," declared San Francisco's *The Examiner*, after the hacktivist group Anonymous had helped to create subway shutdowns.

Here is where the story got a bit uncomfortable for this writer. *The Examiner*'s flash-mob timeline, which ended in a terrifying stew of rioting and revolution, literally began with my name. Back in 2003, as a sort of social experiment, I sent an email to friends and asked them to forward it along, looking to gather "inexplicable mobs" of people around New York. Then, over the span of just a couple of months, I watched

2011 THE YEAR OF UNREST

From January, when a dictatorship fell in the Middle East, to autumn, when protesters settled into US cities, 2011 was a year of marches, mobs and omnipresent occupations. Cameron Bird

14.1 TUNIS, TUNISIA
Sustained protests oust president Zine al-Abidine Ben Ali.

3.2 SANA, YEMEN
Some 20,000 people gather in Sana for a "day of rage".

16.2 PHILADELPHIA
A "flash" snowball fight turns into a near-riot with 14 arrests.

20.2 MOROCCO
Nearly 40,000 people in 57 towns rail against the government.

23.2 ATHENS
Up to 100,000 revolt against pay and pension cuts.

30.5 BOSTON
Following a Facebook invitation, hundreds of kids show up to a night beach party; a Swat team is called.

JANUARY · FEBRUARY · APRIL · MAY · JULY

25.1 CAIRO
Tens of thousands of demonstrators fill Tahrir Square.

14.2 BAHRAIN
Protestors clash with security forces; 44 people are later killed.

17.2 LIBYA
Snipers fire on protesters in what ultimately becomes a months-long civil war.

20.2 CHINA
A protest is quelled when authorities cut mobile services.

16.4 VENICE BEACH, CALIFORNIA
A tweet draws a flash mob to the boardwalk. Gunfire critically wounds one man.

4.7 OHIO
Hundreds of teens hit a fireworks show, provoking skirmishes.

in amazement as my prank turned into a worldwide fad. I should add that the first flash mobs weren't like either the *Friends With Benefits* kind or the burn-and-loot kind – or, maybe I should say, they were a little like both. Like the happy mobs, they were good-natured spectacles, and they often involved the crowd performing some benign group action: bowing before a robotic dinosaur, making birdcalls in Central Park. Like the violent mobs, though, they were highly spontaneous; the crowd was told where they were going and what they would do there only minutes beforehand. And the goal of the get-togethers was not to entertain but, if I may borrow a phrase, to "link up and cause havic".

I even called my events "mobs", as a wink to the scary connotations of a large group gathered for no good reason. But I didn't come up with the name "flash mob" – that honour belongs to Sean Savage, a UC Berkeley grad student who was blogging about my events and the copycats as they happened. He added the word "flash" as an analogy to a flash flood, evoking the way that these crowds (which in the original version arrived all at once and were gone in ten minutes or less) rushed in and out like water from a sudden storm. Savage and I never met while the original mobs were still going on, but today we work just a block away from each other in San Francisco – me at WIRED, him at Frog Design – so we now can get together and commiserate about what's become of our mutual creation. It had been bad enough to see the term get appropriated by Oprah Winfrey to describe a ridiculous public dance party featuring the Black Eyed Peas. Now the media was stretching the term to include just about any sort of group crime.

One reason the term "flash mob" stuck back in 2003 was its resonance, among some sci-fi fans who read Savage's blog, with a 1973 short story by Larry Niven called *Flash Crowd*. Niven's tale revolved around the effects of cheap teleportation technology, depicting a future California where "displacement booths" line the street like telephone booths. The story is set in motion when its protagonist, a TV journalist, inadvertently touches off a riot with one of his news reports. Thanks to teleportation, the rioting burns out of control for days, as thrill-seekers use the booths to beam in from all around to watch and loot. Reading *Flash Crowd* back in 2003, I hadn't seen much connection to my own mobs, which I intended as a joke about the slavishness of fads. I laughed off anyone who worried about these mobs getting violent. In 2011, though, it does feel like Niven got something chillingly correct.

The riots that wracked American cities in the 60s tended to be localised, with rioters taking out their aggression on the neighbourhood in which they lived. By contrast, Nick de Bois says that, of the 165 or so people arrested so far for the looting in Enfield, only around 60 per cent hailed from the local borough. The other 40 per cent commuted in from elsewhere, including locales as far afield as Essex and Twickenham, each a good hour's drive away. Instead of teleportation booths replacing telephone booths, it turned out that those phones merely had to shrink down enough to fit into our pockets.

In trying to understand how and why crowds go wrong, you can have no better guide than Clifford Stott, senior lecturer in social psychology at the University of Liverpool. Stott has risked his life researching his subject. Specifically, he has spent most of his career – more than 20 years so far – conducting a firsthand study of violence among football fans. On one particularly dicey trip to Marseilles in 1998, Stott and a small crowd of Englishmen ran away from a cloud of tear gas only to find themselves facing a gang of 50 French toughs, some of them wielding bottles and sticks. "If you are on your own," a philosophical fellow Brit remarked to Stott at that moment, "you're going to get fucked." This, in a sense, is the fundamental wisdom at the heart of Stott's work – though he does couch it in somewhat more respectable language.

To Stott, members of a crowd are never really "on their own". Based on a set of ideas that he and other social psychologists call the Elaborated Social Identity Model (ESIM), Stott believes crowds form what are essentially shared identities, which evolve as the situation changes. We might see a crowd doing something that appears to us to be just mindless violence, but to those in the throng, the actions make perfect sense. With this notion, Stott and his colleagues are trying to rebut an influential line of thinking on crowd violence that stretches from Gustave Le Bon, whose 1895 treatise, *The Crowd*, launched the field of crowd psychology, up to Philip Zimbardo, the psychologist behind the infamous Stanford Prison Experiment of

2011 THE YEAR OF UNREST CONTINUED

JULY

15.7 SYRIA
Up to 1m people clash with police; several are killed.

27.7 LOS ANGELES
A PR stunt by DJ Ryan Raddon goes wrong when 5,000 people and riot police show up.

AUGUST

6.8 TOTTENHAM, UK
A march on a police station leads to a night of arson.

7.8 ENFIELD, UK
A message calling for "havic" sparks looting in the town centre.

9.8 LIVERPOOL, UK
Vehicles and buildings are set ablaze as rioting spreads.

15.8 SAN FRANCISCO
Hundreds of protesters shut down four subway stations.

SEPTEMBER

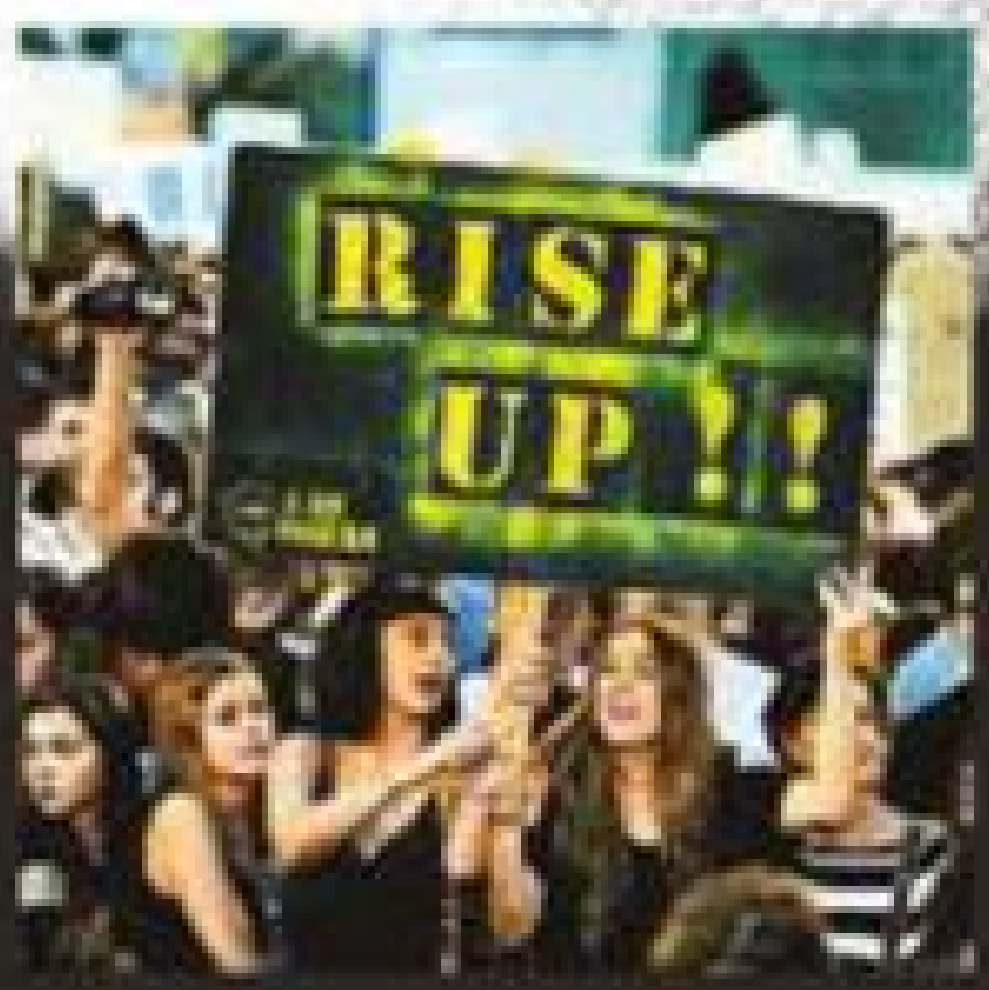
3.9 ISRAEL
At least 300,000 march against income inequality.

17.9 NEW YORK CITY
Day one of Occupy Wall Street brings 1,000 to Manhattan.

OCTOBER

1.10 NEW YORK CITY
More than 700 people are arrested trying to cross Brooklyn Bridge.

6.10 VARIOUS, US
Occupations continue in Boston, Chicago and San Francisco.



15.10 WORLDWIDE
Millions protest during a Global Day of Rage.

20.10 SIRTE, LIBYA
The country celebrates the death of Muammar Gaddafi.

Thousands fill Tahrir Square, Cairo to protest against the country's military rules in January 2011

1971. To explain group disorder, Zimbardo and other mid-20th-century psychologists blamed a process they called deindividuation, by which a crowd frees its members to carry out their baser impulses. Through anonymity, in Zimbardo's view, the strictures of society were lifted from crowds, pushing them towards a state of anarchy and thereby towards senseless violence.

By contrast, Stott sees crowds as the opposite of ruleless, and crowd violence as the opposite of senseless: what seems like anarchic behaviour is in fact governed by a shared self-conception and thus a shared set of grievances. Stott's response to the riots has been unpopular with many of his countrymen. Unlike Zimbardo, who would respond – and indeed has responded over the years – to incidents of group misbehaviour by speaking darkly of moral breakdown, Stott brings the focus back to the long history of societal slights, usually by police, that primed so many young people to riot in the first place.

Meeting Stott in person, one can see how he's been able to blend in with football fans over the years. He's a stocky guy, with a likably craggy face and a nose that looks suspiciously like it's been broken a few times. When asked why the recent riots happened, his answers always come back to poor policing – particularly in Tottenham, where questions over the death of Mark Duggan went unaddressed by police for days and where the subsequent protest was met with arbitrary violence. Stott singles out one moment when police seemed to handle a young woman roughly and an image of that mistreatment was tweeted (and BBMed) throughout London's black community and beyond. It was around then that the identity of the crowd shifted, decisively, to outright combat against the police.

Stott boils down the violent potential of a crowd to two basic factors. The first is what he and other social psychologists call legitimacy – the extent to which the crowd feels that the police and the whole social order still deserve to be obeyed. In combustible situations, the shared identity of a crowd is really about legitimacy, since individuals usually start out with different attitudes towards the police but then are steered toward greater unanimity by what they see and hear. Paul Torrens, a University of Maryland professor who builds 3D computer models of riots and other crowd events, imbues each agent in his simulations with an initial Legitimacy score on a scale from zero (total disrespect for police authority) to one (absolute deference). Then he allows the agents to influence one another. It's a crude model, but it's useful in seeing the importance of a crowd's initial perception of legitimacy. A crowd where every member has a low L will be predisposed to rebel from the outset; a more varied crowd, by contrast, will take significantly longer to turn ugly, if it ever does.

It's easy to see how technology can significantly change this starting position. When that tweet or text or BBM blast goes out declaring, as the Enfield message did, that "Police can't stop it," the eventual crowd will be preselected for a very low L indeed. As Stott puts it, flash-mob-style gatherings are special because they "create the identity of a crowd prior to the event itself", thereby front-loading what he calls the "complex process of norm construction", which usually takes time. He hastens to add that crowd identity can be pre-formed through other means, too, and that such gatherings also have to draw from a huge group of willing participants. But the technology allows a group of like-minded people to gather with unprecedented speed and scale. "You've only got to write one message," Stott says, "and it can reach 50, or 500, or even 5,000 people with the touch of a button." If only a tiny fraction of this quickly multiplying audience gets the message and has already prepared itself for disorder, then disorder is what they are likely to create.

The second factor in crowd violence, in Stott's view, is simply what he calls power: the perception within a crowd that it has the ability to do what it wants, to take to the streets without fear of punishment. This, in turn, is largely a function of sheer size – and just as with legitimacy, small gradations can make an enormous difference. We often think about flash mobs and other internet-gathered crowds as just another type of viral phenomenon, the equivalent of a video that gets a million views instead of a thousand. But in the physical world, doubling the expected size of a crowd can create a truly combustible situation.

It was this problem of sheer volume, that tripped up Ryan Raddon – aka Kaskade,

25.10 CALIFORNIA
An Iraqi war veteran is critically injured on an Occupy crackdown.

NOVEMBER

6.11 WASHINGTON
10,000 protest against a proposed oil pipeline from Canada.

NOW WORLDWIDE
Occupy Wall Street goes global, with more than 1,000 spinoffs.

PHOTOGRAPHY: GETTY

a Californian electronic dance artist – in his ill-fated PR stunt last July. The plan was simple enough: Raddon would put on a short show outside the iconic Grauman's Chinese Theatre. He got a permit from the fire department to shut down one lane of traffic. At 1:36 pm, he sent out the fateful tweet: *Today@6pm in Hollywood @ Mann's Chinese Theatre. ME+BIG SPEAKERS+ MUSIC=BLOCK PARTY!!! RT!*

There was room for a maximum audience of a thousand. By the time Raddon arrived, the crowd had swelled to 5,000, stretching both ways down the block and obstructing all six lanes of traffic. Riot police were dispatched down Hollywood Boulevard.

Every disorderly flash mob mentioned in this article has been, at root, a mega-underground phenomenon. In many cases, this brings us back around to the uncomfortable subject of race. In the US, the biggest and most important of the urban flash mobs that politicians have railed against weren't gathered by calls to violence, as in London. Instead, they were essentially about African-American teenagers showing their numbers, about kids taking over – for a brief window of time – some highly visible public spaces where they normally feel less than welcome. In Kansas City, a police investigation found that the mobs in April 2010 were gathered via Facebook, bringing between 700 and 900 kids to the aptly named Country Club Plaza, lined with plush stores. Elijah Anderson, a Yale sociologist and Philly native who studies poor urban communities, has coined the term "cosmopolitan canopy" to describe these kinds of spaces. They're the places where people of different races and class backgrounds come together, which makes them the closest thing we have today to a commons; for teens, especially poorer teens, the cosmopolitan canopy represents society and authority in the way that a government or bank headquarters ought to but doesn't.

It's not too far a stretch to extend this same idea into the realm of protests. This is, at root, the way that Occupy Wall Street defied expectations to become a genuine political force. The media harped on about how these protests grew through Twitter, but it was really the movement's Tumblr – wearethe99percent.tumblr.com – that made it work. Those photos of struggling Americans essentially virtualised the occupation; the street protesters were merely the visible symbol of the giant, subterranean mob of Americans struggling to get by. What's really revolutionary about all these gatherings – what remains both dangerous and magnificent about them – is the way they represent a disconnected group getting connected in physical space.

None of this can entirely explain Enfield, though. What remains shocking about that riot is the way it evolved in the moment, forming and reforming, eluding attempts to contain it. I keep coming back to one particular video from that night, a 50-second clip that captures the moment when G. Mantella, a family jewellery store, got hit for £40,000 in merchandise. Seriously, if you're near a browser go and watch the video right now: it's at wrdm.ag/riotvideo. The camera moves at walking pace toward the store, through a large but loose milling crowd. Who is a spectator? Who is a looter? Everyone looks simultaneously like neither and both. There's a remarkable moment at 0:30 where a guy in a hoodie walks by, clutching a smartphone to his chest, looking cannily over his shoulder. He's clearly taken on the group identity, but his peculiar expression betrays something strange about the nature and extent of his affiliation. The device in his hands connects him but it also frees him, allowing him to stay in and out of the mob at the same time.

The camera approaches the jewellery store just as three police vans come screaming up, and the looters stream out of the store at top speed. It's the only point in the video that you see a real, thick, densely packed crowd, and that's at the moment right before it gets dispersed. What isn't clear from the video – what I didn't realise until I took the train up to Enfield and made my own walk from the station to the square – was just how open this whole space is, how far back the buildings sit from the relatively wide streets. In many mob incidents, it takes the confidence of thousand-strong groups to confront the police. Here in Enfield, you had a few hundred people ranging around, gathering to loot, dispersing, and then reconvening soon thereafter to strike again. This was the pattern in Brixton, too, in south London, where rioters looted and burned a shopping district, scattered, and then re-emerged a kilometre away to hit an electronics superstore. As Nick de Bois says, "It was organised, but it was dynamic."

Really, what the video reveals is an extra dimension to the phenomenon of "power", which turns out to be about more than sheer numbers. In the pre-mobile phone era – as Cliff Stott observed in Marseilles – overall numbers didn't matter one bit if you could not keep physically connected. In *Among The Thugs*, Bill Buford's first-person account of football hooliganism, he describes the remarkable discipline that even these drunken, anarchic yobs had to maintain to carry out violence against opposing fans: "Everyone is jogging in formation, tightly compressed, silent." Step out of the phalanx to grab a pint and you might never find your fellows again; in the meantime, the opposing mob might find you alone. Today, by contrast, a crowd's power is amplified by the fact that its members can never really get separated. A crowd that's always connected can never really be dispersed. It's always still out there.

Among the more idealistic people who organise protests, not riots, there are dreams of creating special tools that can guide crowds in the moment, making them even more effective at thwarting or eluding police. At the London Hackspace, a maker workshop in Hackney, I met Sam Carlisle, codeveloper of an app called *Sukey*. Initially concocted to aid a series of student actions last winter – protesting against the enormous hike in university fees that was being pushed through by the new Coalition government – *Sukey* has the very specific goal of frustrating that police tactic of kettling, which can imprison activists on the street for hours. To combat this manoeuvre, Sukey polls protesters in real time to identify exit points to public spaces that are blocked by police. Carlisle and his fellow developers are talking to protest groups about how to expand the app's reach, creating dedicated apps for multiple smartphone platforms, in multiple languages, for use all around the world.

It's a great idea in principle. But it seems hard to believe that any dedicated app for crowd communication could possibly be more effective than BBM was in London. In a protest crowd of any significant size, there will be a huge contingent that steps out at the spur of the moment, with no thought of downloading a special app or even bookmarking a URL. When disorder strikes or danger looms, they will fall back on the social ties they have already established, the tools they already possess, the patterns they already follow.

Among tech journalists, BlackBerry is considered to be "old-fashioned, lame, commoditised technology", as Mike Butcher puts it. But BBM is private, decentralised, blindingly fast and – most important – ubiquitous. Robert Capps has called this phenomenon the Good Enough Revolution (WIRED US 17.09). For technology to become effective as a tool for civic disorder, it first had to insinuate itself into people's daily lives. Now that it has, there can be no getting rid of it. The agent provocateur lives inside our pockets and purses and cannot be uninstalled.

PHOTOGRAPHY: WIREIMAGE

By the end of *Flash Crowd*, Niven's fictional journalist narrator who ponders "How many people would be dumb enough to come watch a riot?", the guy accused of setting off the giant riot in the first place has dreamed up a system to stop the violence from recurring. It involves the police both curtailing the teleportation technology and commandeering it. Police, in his scheme, would get to ban all arrivals near the site of unrest, switching the booths so that they only send – directly to the inside of a police station or mass jail.

In the aftermath of the UK riots, the proposals floating around Parliament sounded every bit as intrusive, if not more so. Representatives of Facebook and Twitter were called in to discuss emergency shut-down plans to throttle their services should similar incidents occur in the future. Research In Motion, the maker of BlackBerry, has promised (or so it has been reported) that it would halt BBM if anything like the UK riots happened again. But for the same basic reason that the technologies have proved instrumental in crowd disorders – the ubiquity of their use, among not just young people but all classes and professions – one has to doubt whether governments and technology companies will really have the stomach to carry out these draconian countermeasures. Vital emergency personnel routinely rely on BBM and other smartphone services, so an outright shutdown might easily sacrifice more lives than it saves.

So what's a police force to do? In late September in the US, the Dallas Police Department played host to a conference called Social Media, the Internet, and Law Enforcement (SMILE), and this question was very much in the air. Mike Parker, a captain at the Los Angeles County Sheriff's Department, said that his force monitors social media and looks to disrupt problems before they start. He used an example of an entertainer – he wouldn't specify the name – who tweeted to his half-million followers that he would be making a guerrilla appearance at a local electronics store. Once the police were tipped off to this, they helped to make a clever intervention: by the time the celebrity showed up, store employees had set up a folding table near the front for him, and two police officers hung around to watch. "You can imagine how happy he wasn't, when he showed up," Parker says with barely restrained glee. "His whole plan was to create a spontaneous, 'cool' event, and instead it ended up looking organised."

But to stay abreast of such would-be mobs, police would need to monitor social media with a level of intelligence – attuned to popularity, cognisant of slang, filtering for location – that right now is beyond the reach of even sophisticated tech startups, let alone cash-strapped police departments. The pitfalls of this task were apparent when David Gerulski, from a firm called DigitalStakeout, took the podium to give a demo. With his service, he promised the assembled officers, they could stop tinkering with social media and "go back to kicking down doors and sticking guns in people's faces". On the big screen, he projected a map from his software's filtering system showing recent and potentially dangerous tweets from Dallas. He drilled down on one tweet in particular, from a user named Evy: *suck a dick and die! Jk. (:*

"Who's she talking to? What's she talking about?" he asked in a portentous tone. "It wasn't that long ago that Representative Giffords got shot in Arizona. So, with an angry post like this, you want to find out, is this serious?"

"It says JK," someone called out from the audience. "As in: 'just kidding.' "

"Ah," Gerulski said. "I didn't know the JK."

The most sensible way of looking at this problem is to ask how policing strategies that succeed in the offline world might be extended on to social media. The key to "community policing" has always been that police can gain trust over time but then – when tensions run high – can also quickly demonstrate a presence, making it clear that the law is watching. At SMILE, Scott Mills, an officer from Toronto who works with teens (his Twitter handle, @GraffitiBMXCop, gives a sense of his particular cred), puts this very principle into practice, integrating location-based social media with "walking the beat". When Mills is called to a crime scene, he checks into Foursquare – and he knows so many kids, he says, that they come find him.

Beyond smarter policing, though, there is only so much that government can do. We probably need to accept, as a simple fact of life in the digital age, that the freedom of assembly will necessarily imply the freedom of an enormous group of people – sometimes people who don't always behave themselves – to assemble with little or no warning. It's worth mentioning that in *Flash Crowd*, the journalist never gets around to pitching the authorities on his plan to stop the riots. In the story's very last lines, an anchorman at his network tells him about a new flash crowd that's just cropped up. This one is nearly as large, but it's merely there to witness the red tide at Hermosa Beach, which a celebrity had praised on TV. "It's a happy riot," his colleague says, a bit perplexed. "There's just a bitch of a lot of people." The journalist takes the assignment, grabs a camera, steps into the booth, and disappears.

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Standoff in Los Angeles in July 2011, when a PR street stunt by DJ Ryan Raddon gets out of hand

By MICHAEL WATTS

Still life: DIVER AND AGUILAR
Photography: MARTIN BRENT

The light-bulb moment

Harald Haas can send movies, online games, even Skype calls through a household light bulb. Meet Li-Fi, his LED-based alternative to Wi-Fi

HARALD HAAS HAS QUITE A PARTY TRICK.

USING OFF-THE-SHELF ELECTRONICS, HE CAN STREAM VIDEOS USING AN ORDINARY LIGHT BULB FITTED WITH SIGNAL-PROCESSING TECHNOLOGY OF HIS OWN DESIGN.

The lamp shines directly on to a hole cut into the oblong box on which it sits. Inside this box is a receiver that converts the light signal into a high-speed data stream, and a transmitter that projects the data on to a screen as a short video. If Haas puts his hand in front of the lamp, excluding the light, the video stops.

Haas, 43, holds the chair of mobile communications at Edinburgh University's Institute for Digital Communications. His demo is scientifically groundbreaking: it proves that large amounts of data, in multiple parallel streams, can be transferred using various forms of light (infrared, ultraviolet and visible). The technology, he says, has huge commercial potential. His device can be used with regular lighting and electronics – albeit reconfigured – and could transform the way we access everything from video to games, accelerating the speed of internet access by many hundreds of megabits. It could let us download movies from the lamps in our homes, read maps from streetlights and listen to music from illuminated billboards in the street.

Haas's discovery is based on a subset of optical technology called visible light communication (VLC), or Li-Fi, as it has been dubbed. VLC exploits a hack of human perception: light-emitting diodes can be switched on and off faster than the naked eye can detect, causing the light source to appear to be on continuously. Rapid on-off keying enables data transmission using binary code: switching on an LED is a logical "1", switching it off is a logical "0". Thereby flows the data.

The potential applications are enormous: divers working at depths could use light to communicate; air passengers could connect to the internet through the LEDs inside the aircraft. Haas sees the technology potentially disrupting industries from telecoms to advertising.

Research into VLC has been conducted in earnest since 2003, mainly in the UK, US, Germany, Korea and Japan. Experiments have shown that LEDs can be electronically adapted to transmit data wirelessly as well as to provide light. VLC is faster, safer and cheaper than other forms of wireless internet, advocates say – and so could eliminate the need for costly mobile-phone radio masts.

German-born Haas sits in his office in Edinburgh University. Several of the university's faculties, led by the informatics department, are involved in his project, called D-LIGHT; the university, a sponsor, owns the intellectual property. A month before WIRED's visit, Haas prompted stunned applause when he demonstrated his technology live to the audience at TEDGlobal in his adopted city. "To my disgrace," he confesses, "I didn't know anything about TED before [my talk]. Now it's like winning the lottery – every day, I get five to ten emails, all very positive and excited. They are excited because it's easy to comprehend the unique opportunity in this technology."

In person, Haas is calm, humorous and cerebral, unfussed by his academic celebrity and unmotivated, he says, by the prospect of wealth. Married to a fellow German and graduate of the University of St Andrews, he jokes about their young children picking up an Edinburgh burr. He does not seek fame, he says, only for his work to fulfil its potential. "I'm less interested in what may change the world in 20 years' time," he says. "I'm looking into fundamentals of science that could do so within the next few years."

Haas grew up in Nuremberg. His thinking was greatly influenced by his father, an engineer at Siemens. He recalls a teenage fascination with LEDs – a new technology at the time – and inventing, at around 13, a rev counter that neighbours wanted to install in their cars. "I played a lot with electronics when I was a kid," he says. "I wanted to understand the transistor, and I wrote an essay [about them] at school. Everyone thought, 'What is this strange guy doing here?'"

He followed his father into Siemens, developing mobile-phone chips in Munich, but grew bored and escaped to academia. In 1995 he went on a scholarship to Mumbai, where he helped Siemens to develop a mobile-phone network. By 1999, he was at Edinburgh University, where he and his tutor, Gordon Povey, now his business partner, developed a patent for the 3G Universal Mobile Telecommunications System, which they sold to Siemens.

His office is now in the university's Alexander Graham Bell building. In 1880, Bell became the first person to send a voice message by modulated light. Using his "Photophone", Bell directed sunlight at a parabolic mirror that captured and projected his vocal vibrations. Sunlight's unpredictability sidelined his idea. Radio transmission seemed more promising.

Above: Harald Haas at Edinburgh University's school of engineering

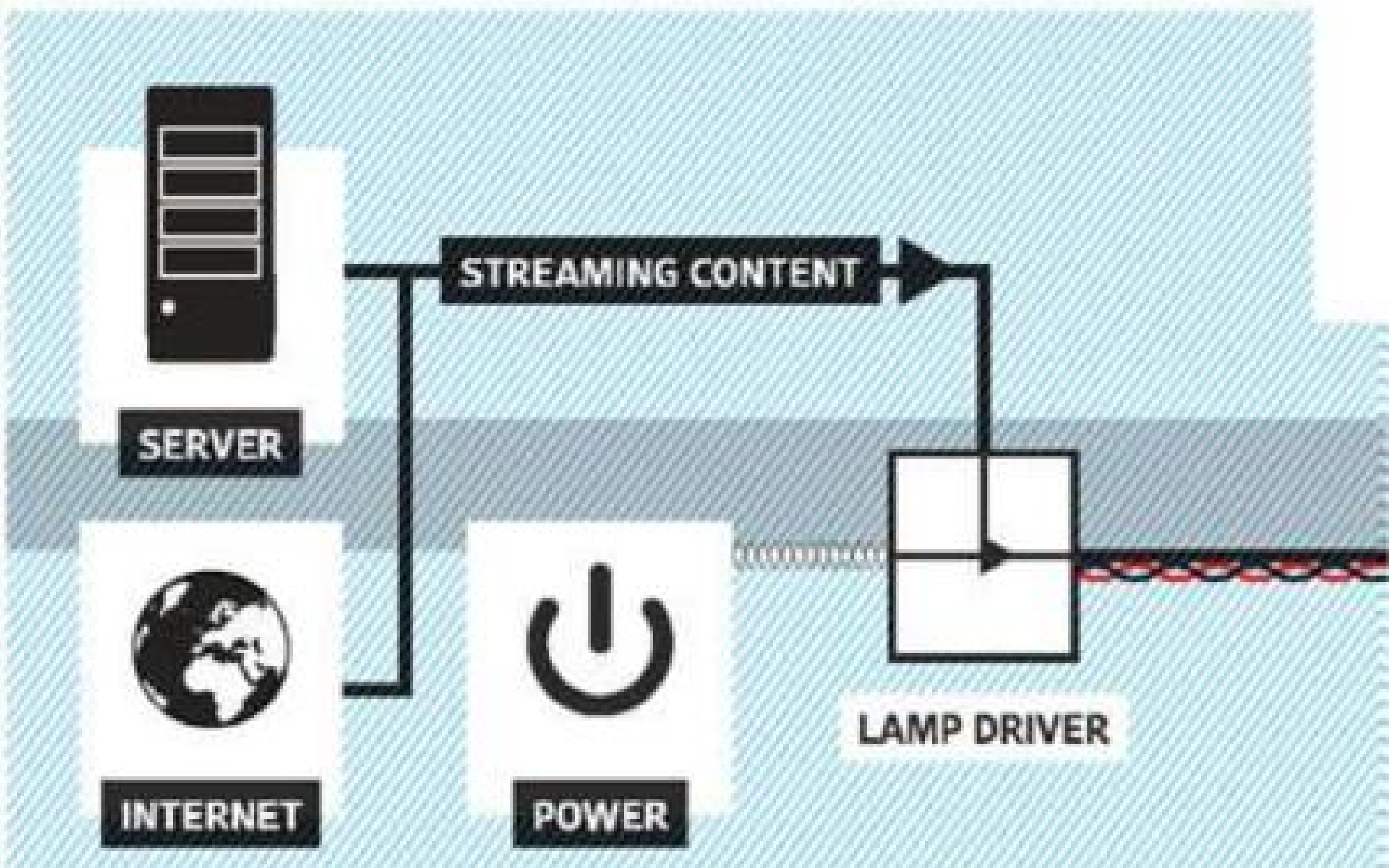
Now Haas is fulfilling Bell's ambition with LEDs, whose principal technology was discovered more than 100 years ago. LEDs were little used until the late 20th century, when they began appearing in car-instrument panels, infrared handsets and TVs. They are brighter, tougher and more reliable – if costlier – than the incandescent bulbs they are gradually replacing.

Haas has a small lab stuffed with equipment, including the now-famous table lamp and its box of electronics. It was here in 2007 that his research assistant, Mostafa Afgani, first sent data using light signals. Haas's invention centres on how these signals are modulated: the information, embedded within visible light emitted from the LEDs, is transmitted by means of many subtle changes made to the intensity of the light at the ultra-high rate of 100 million cycles per second (100MHz). The photo-detector in Haas's box monitors these tiny variations and converts them back into a digital signal, from which the transmitted information is extracted.

Early in his research, Haas became intrigued by the properties of two wireless-technology systems: multiple-input and multiple-output (Mimo), which employs antennas at both the receiver and transmitter to improve signal; and orthogonal frequency-division multiplexing (OFDM), found in DAB radio and 4G mobile communications.

A weakness of OFDM is its high peak-to-average power ratio, which produces wide fluctuations in the signal. But Haas could work this into an advantage for optical communications if he used those variations to crank up intensity. This meant that he could transmit data streams in parallel, and at rates limited only by the number of LEDs. He calls his transmission technique spatial modulation OFDM, or SIM-OFDM. "We exploit three dimensions," he explains. "Time, frequency and space. No one has ever done this before."

Haas, Povey and Afgani founded a company, VLC Ltd, to market their transceiver technology and a seed-funding round was completed last November. A larger "Series A" VC funding round is expected later this year. But the team is in a race to market: rival companies are already selling and trialling VLC products. In Tokyo, Nakagawa Laboratories, where Haas spent a semester in 2003, has developed what it calls underwater visible light communications: a means of picking up a scuba-diver's voice using a microphone in an LED light and sent to another diver. In December 2010, US technology firm LVX started providing light-powered broadband services to six public buildings in the Minnesotan town of St Cloud. LVX says it's demonstrating "fibre optics without the fibre". The company would not comment, but is said to have transmitted data at an unimpressive 3Mbps.



HOW IT WORKS

An overhead lamp fitted with an LED containing signal-processing technology (*right*) streams data embedded in its beam at ultra-high speeds to the photo-detector. A receiver dongle then converts the tiny changes in amplitude into an electrical signal, which is then converted back into a data stream and transmitted to a computer or mobile device.

A **VLC industry is beginning to cohere.** Last autumn a report by industry researcher Global Business Intelligence, *Visible Light Communication (VLC) – A Potential Solution to the Global Wireless Spectrum Shortage*, mentioned half a dozen companies that are active in the field, including Casio and Intel. Samsung and Boeing were not named, but are also thought to be exploring VLC. Last October, a group of companies from Germany, Norway, Israel and the US formed the Li-Fi Consortium to promote optical wireless communications.

It's easy to see why VLC could disrupt the way data is delivered. It offers relatively high bandwidth – and visible light is free and safe. Imagine being able to use your laptop or tablet wherever in the world you can find a modified LED light. No more scrambling for access codes, or searching for hotspots, or risking leaks and electromagnetic interference, because artificial light, unlike radio waves, doesn't penetrate walls. You can control its beam, like a torch; and even if that torchlight is dimmed to the point of appearing switched off, you remain connected, as the LED signal is still operating.

Evangelists emphasise VLC's advantages in hazardous conditions or tough environments. They say it will transform air travel by allowing overhead cabin lights to connect mobiles and laptops in-flight; and that it will improve conditions for those working underwater – on oil rigs, for example – where radio waves cannot penetrate. Traffic lights could better regulate traffic flow using data; and LED car lights might alert drivers when other vehicles are too close. More pervasively, anyone seeking an internet connection could connect using light from streetlamps and electric shop signs.

One major downside is that artificial light cannot approach the range and penetration of radio waves: think of the limitations of a torch beam or car headlamp. So a mobile phone enabled by Li-Fi (through its inbuilt photo-receiver) will never be as useful as radio in the open air. Still, Li-Fi could certainly help relieve pressure on the existing networks' capacity. And it will offer an attractive alternative to the congested radio frequency spectrum. The US Congress is contemplating whether to reallocate television broadcasters' unused spectrum and auction it for wireless broadband.

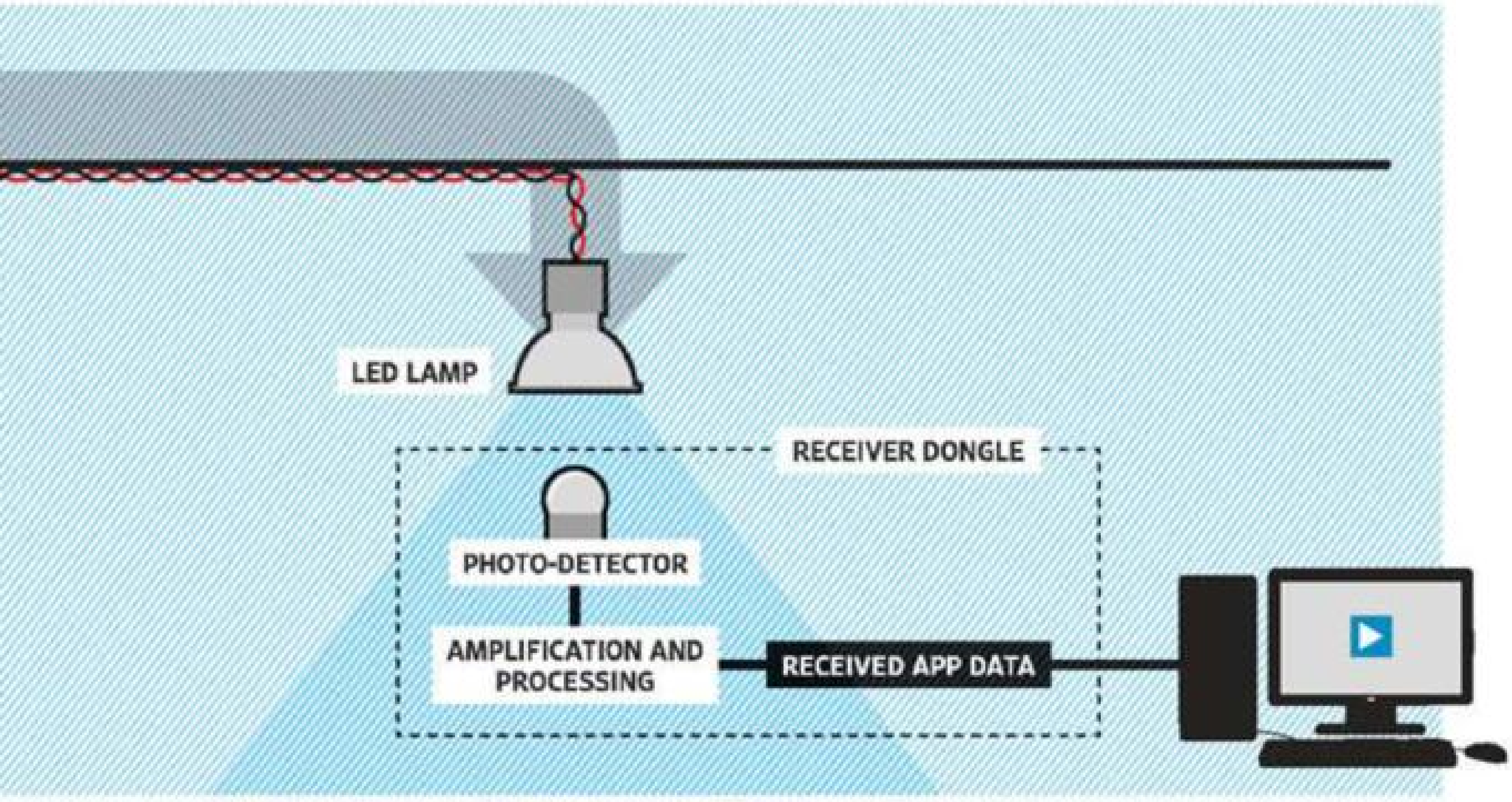
Li-Fi use in aeroplanes is a priority for Haas and Povey. One of the "ten or 11" applications they are considering for their technology could be spurred on by a deal with a German aircraft manufacturer they will not name. The German government has awarded them a €700,000 (£600,000) grant to develop a system that will provide continuous internet access via an aircraft's avionics data-bus system. Haas, though, has bigger ambitions: he wants to help the manufacturer build planes in modules. This would require less hard-wiring. "They want greener and lighter aircraft, and for seating to be flexible," he says. "And making things modular means you can't wire them up."

They are also in talks with the Clinical Research Imaging Centre at Queen's Medical Research Institute in Edinburgh. Radiology equipment is highly sensitive to electromagnetic interference, and the distribution of data produced by computerised axial tomography (CAT) or magnetic resonance imaging (MRI) scans requires extensive cabling. VLC would make it possible to distribute scans widely and quickly. But first the team must trial their Li-Fi prototype at a suitable location. They like the idea of a school: some local authorities have expressed concern about alleged health effect on pupils from radio transmitters and Wi-Fi.

Meanwhile, data transfer using VLC is getting faster and more efficient. Last year, researchers from Siemens Corporate Technology in Munich transmitted data over five metres with an Osram LED. And in August, the Heinrich Hertz Institute in Berlin claimed to have demonstrated 800Mbps transceivers under laboratory conditions; by comparison, few wireless service providers muster speeds above 100Mbps.

At TEDGlobal, Haas demonstrated a data rate of transmission of around 10Mbps – comparable to a fairly good UK broadband connection. Two months later he had achieved 123Mbps. Now he's targeting 600Mbps. He has, effectively, thrown down a challenge

The VLC wish-list: LED lighting module (1), multi-chip LED element (2), LED with lens (3), VLC receiver module (4)



to the competition: we can squeeze more data from a light bulb than you can.

Mark Leeson, a professor at Warwick University's School of Engineering, is more cautious about VLC's prospects. He told *New Scientist* last July that "there has been a lot of early hype". While conceding to WIRED the "important contribution of the Edinburgh group", he thinks problems with the technology are yet to be solved: "The really big challenge is to provide an uplink from the receiving device back to the ceiling fixture. This may entail the use of a different wavelength in the infrared, or even RF [radio frequency]. As currently presented, VLC is [only] a broadcast technology."

A common criticism is that any blocking or movement affecting the light source could interrupt the line-of-sight transmission – as Haas demonstrated at TED. He dismisses this objection by gesturing to the space under his office table. "In a room, this will never happen," he says. "See. Even under a table, it gets a signal, because light travels in straight lines but is reflected easily." He points at the ceiling fixture. "If you have enough illumination, sufficient for reading, then you can guarantee enough signal power for wireless communication."

Haas argues that the transmission rate at the Hertz Institute "was not in real time". "They wouldn't be able to transmit a video in the way we demonstrated it at TED. In a comparable environment like ours, in fact, they achieve 83Mbps."

There's also the infrastructure challenge of getting data to the lights; after all, a light fixture has to be plugged into something. "Are people really going to wire network cabling to every single light bulb?" asks Dan Ryan, cofounder of ByteLight in Boston, whose VLC technology is focused on location applications. "There's been a lot of talk about using powerline communications to get data to the bulbs. But I have yet to see anyone reliably demonstrate this at high data rates."

Povey answers this by minimising its importance. "Every wireless-communications system has a backhaul of some type," he says. "Many smart lighting systems already have control bus cables, which we can make redundant. Wi-Fi has the same issue: you need to run a cable to every access point. Powerline communications are getting quite mature, and many people find them more reliable than using Wi-Fi. Wi-Fi speeds will not get anywhere near 600Mbps in a practical setting."

Even if his own technology is adopted, however, Ryan anticipates resistance to VLC from mobile-device manufacturers and the lighting industry. "Why would lighting manufacturers make their bulbs VLC-enabled if mobile devices can't receive the data? And why would a mobile-device manufacturer make their phones VLC-enabled if there are no bulbs to talk with? What we have is a chicken-and-egg problem. What will likely happen is that VLC will roll out in 'closed-system use' cases, where the facility manager controls both the lighting and the devices receiving the data. Military, hospital and factory-type environments all come to mind."

"There are always detractors," Povey says. "Always people saying, 'You won't achieve these data rates.' In my previous companies, people kept on, 'Oh, you should give up now,' but I always succeeded in every one that I did."

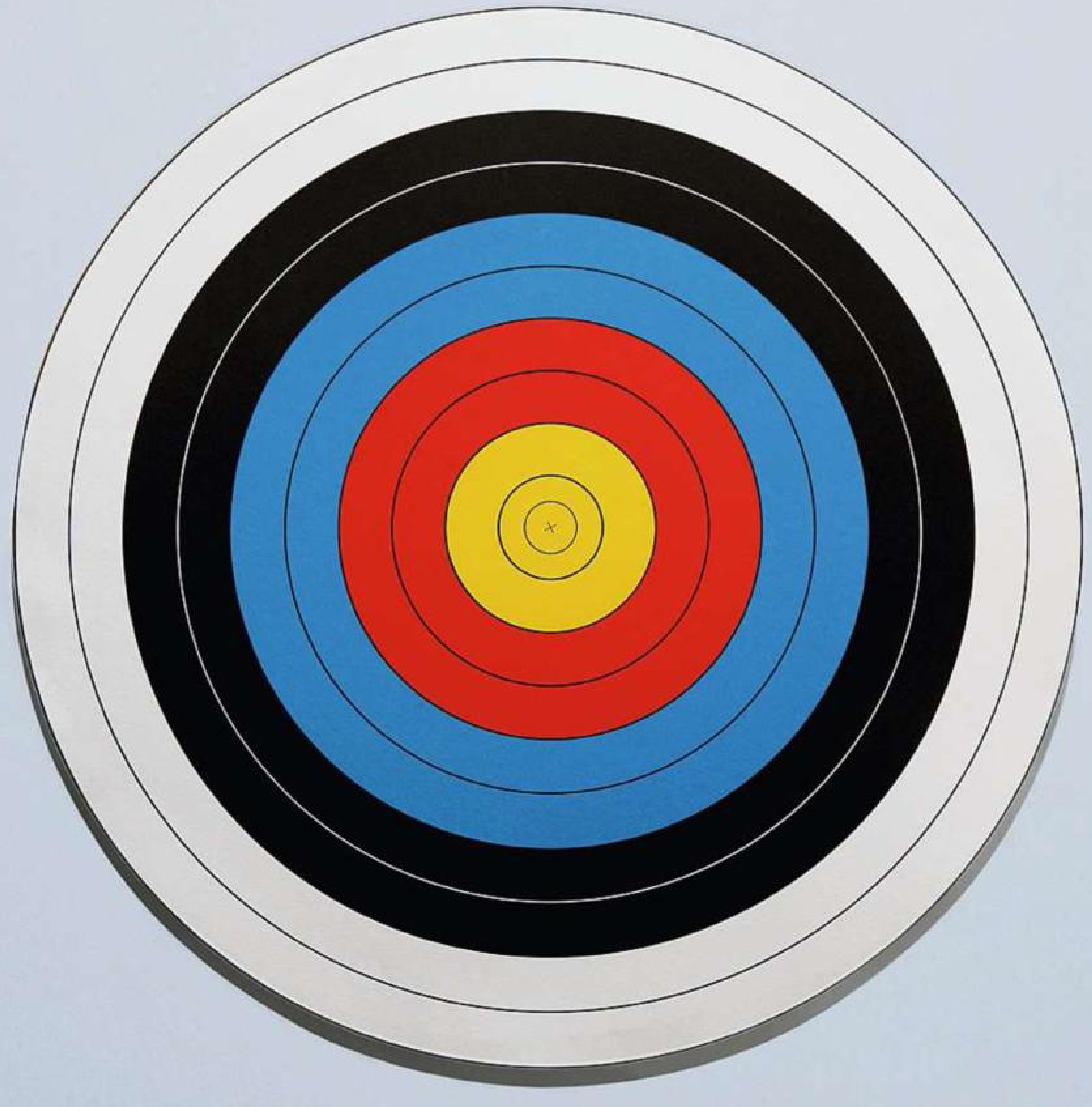
VLC Ltd is currently looking for more investment, and seeking an initial partnership with a smart-lighting company to launch its first products by June 2012. Then, within a decade, Povey believes, the likes of Homebase and B&Q will be stocking their modified light bulbs.

But first, they must show their fully functioning VLC-enabled light bulb to a potential manufacturer. So they have enlisted the design expertise of a leader in LED lighting, the West Midlands company Integrated System Technologies, based in Aldridge. "We've demonstrated the technology and we've got some funding," says Haas. "But we shouldn't get overexcited. We are now in base camp. Walking further up the hill is another story."

AT TED, HAAS'S DATA TRANSFER RATE WAS 10MBPS. HE'S NOW AIMING FOR 600MBPS

Last October, Haas was a finalist at the prestigious World Technology Network Awards in New York City. The awards are presented to individuals and companies who, in the opinion of judges such as inventor Ray Kurzweil, are performing innovations of "the greatest likely long-term significance". Competing against the likes of Bell Labs, Yahoo! and Facebook, Haas lost to telecoms giant Alcatel-Lucent. "I think the nomination came a year too early," he shrugged after the awards ceremony. "After all, we don't have an actual product as yet." W

Michael Watts wrote about OPOWER in 08.11



Dead-end experiments, useless drugs, unnecessary surgery.

WHY SCIENCE IS FAILING US

TRIALS AND ERRORS

by Jonah Lehrer

Photography: Mauricio Alejo

On November 30, 2006, executives at Pfizer – the largest pharmaceutical company in the world – held a meeting with investors at the firm's research centre in Groton, Connecticut. Jeff Kindler, then the CEO, began the presentation with an upbeat assessment of the company's efforts to bring new drugs to market. He cited "exciting approaches" to the treatment of Alzheimer's disease, **fibromyalgia and arthritis. But Kindler was most excited about a new drug** called torcetrapib, which had recently entered Phase III clinical trials, the last step before filing for approval. He confidently declared that it would be "one of the most important compounds of our generation".

His enthusiasm was understandable: the potential market for the drug was enormous. Like Pfizer's blockbuster medication Lipitor – the most widely prescribed branded pharmaceutical in America – torcetrapib was designed to tweak the cholesterol pathway (in the UK, simvastatin is the most-prescribed, and serves a similar function). Lipitor works by inhibiting an enzyme that plays a key role in the production of cholesterol in the liver. The drug lowers the level of low-density lipoprotein (LDL) or so-called bad cholesterol. Recently, scientists have begun to focus on a separate part of the cholesterol pathway, the one that produces high-density lipoproteins (HDL). One function of HDL (referred to as "good cholesterol") is to transport excess LDL back to the liver, where it's broken down. Torcetrapib was designed to block a protein that converts HDL cholesterol into its sinister sibling, LDL. In theory, this would cure cholesterol problems, creating a surplus of the good stuff and a shortage of the bad. In his presentation, Kindler noted that torcetrapib had the potential to "redefine cardiovascular treatment".

There was a vast amount of research behind Kindler's bold proclamations. The cholesterol pathway is one of the best-understood biological feedback systems in the human body. Since 1913, when Russian pathologist Nikolai Anichkov first experimentally linked cholesterol to the build-up of plaque in arteries, scientists have mapped out the metabolism and transport of these compounds in exquisite detail. Torcetrapib had already undergone a small clinical trial, which showed that the drug could increase HDL and decrease LDL. Kindler told investors that, by the second half of 2007, Pfizer would begin applying for approval from the US Food and Drug Administration (FDA). The success of the drug seemed a sure thing. And then, just two days later, on December 2, 2006, Pfizer issued a stunning announcement: the torcetrapib Phase III clinical trial was being terminated. Although the compound was supposed to prevent heart disease, it was actually triggering higher rates of chest pain and heart failure and a 60 per cent increase in overall mortality. The drug appeared to be killing people. That week, Pfizer's value plummeted by $21 billion (£14 billion).

The story of torcetrapib is one of mistaken causation. Pfizer was operating on the assumption that raising levels of HDL cholesterol and lowering LDL would lead to a predictable outcome: improved cardiovascular health. Less arterial plaque. Cleaner pipes. But that didn't happen. Such failures occur all the time in the drug industry. (According to a recent analysis, more than 40 per cent of drugs fail Phase III clinical trials.) And yet there is something particularly disturbing about the failure of torcetrapib. After all, a bet on this compound wasn't supposed to be risky. For Pfizer, torcetrapib was the pay-off after

STYLING: WENDY SCHELAH/HALLEY RESOURCES

decades of research. Little wonder that the company was so confident about its clinical trials, which involved 25,000 volunteers. Pfizer invested more than $1 billion in the development of the drug and $90 million to expand the factory that would manufacture the compound. Because scientists understood the individual steps of the cholesterol pathway at such a precise level, they assumed they also understood how it worked as a whole.

This assumption – that understanding a system's constituent parts means we also understand the causes within the system – is not limited to the pharmaceutical industry or even to biology. It defines modern science. In general, we believe that the so-called problem of causation can be cured by more information. Scientists refer to this process as reductionism. By breaking down a process, we can see how everything fits together; the complex mystery is distilled into a list of ingredients. And so the question of cholesterol's relationship to heart disease becomes a predictable loop of proteins tweaking proteins, acronyms altering one another. Modern medicine is particularly reliant on this approach. Every year, nearly $100 billion is invested in biomedical research in the US, all of it aimed at teasing apart the invisible bits of the body. In Europe, that figure is estimated to be at least €17 billion (£15bn). We assume that these new details will finally reveal the causes of illness, pinning our maladies on small molecules and errant snippets of DNA. Once we find the cause, of course, we can begin working on a cure.

The problem with this assumption is that causes are a strange kind of knowledge. This was first pointed out by David Hume, the 18th-century philosopher. He realised that, although people talk about causes as if they are real facts – tangible things that can be discovered – they're actually not at all factual. Instead, Hume said, every cause is just a slippery story, a catchy conjecture, a "lively conception produced by habit". When an apple falls from a tree, the cause is obvious: gravity. Hume's sceptical insight was that we don't see gravity – we see only an object tugged towards the earth. We look at X and then at Y, and invent a story about what happened in between. We can measure facts, but a cause is not a fact – it's a fiction that helps us make sense of facts.

The truth is, our stories about causation are shadowed by all sorts of mental short cuts. Most of the time, these work well enough. They allow us to discover the law of gravity, and design wondrous technologies. However, when it comes to reasoning about complex systems – say, the human body – these short cuts go from being slickly efficient to outright misleading. Consider a set of classic experiments designed by Belgian psychologist Albert Michotte, first conducted in the 40s. His research featured a series of short films about a blue ball and a red ball. In the first film, the red ball races across the screen, touches the blue ball and then stops. The blue ball, meanwhile, begins moving in the same basic direction as the red ball. When Michotte asked people to describe the film, they automatically lapsed into the language of causation. The red ball hit the blue ball, which caused it to move. This is known as the launching effect, and it's a universal property of visual perception. Although there was nothing about causation in the two-second film – it was just a montage of animated images – people couldn't help but tell a story about what had happened. They translated their perceptions into causal beliefs.

Michotte then began subtly manipulating the films, asking the subjects how the new footage changed their description of events. For instance, when he introduced a one-second pause between the movement of the balls, the impression of causality disappeared. The red ball no longer appeared to trigger the movement of the blue ball. Rather, the two balls were moving for inexplicable reasons.

Michotte would go on to conduct more than 100 of these studies. Sometimes he would have a small blue ball move in front of a big red ball. When he asked subjects what was going on, they insisted that the red ball was "chasing" the blue ball. However, if a big red ball were moving in front of a little blue ball, the opposite occurred: the blue ball was "following" the red ball.

There are two lessons to be learned from these experiments. The first is that our theories about a particular cause and effect are inherently perceptual, infected by all the sensory cheats of vision. Hume was right that causes are never seen, only inferred, but the truth is we can't tell the difference. And so we look at moving balls and see causes, a melodrama of taps and collisions, chasing and fleeing.

The second lesson is that causal explanations are oversimplifications. This is what makes them useful – they help us grasp the world at a glance. For instance, after watching the short films, people immediately settled on the most straightforward explanation for the ricocheting objects. Although this account felt true, the brain wasn't seeking the literal truth – it just wanted a plausible story that didn't contradict observation. There's a fundamental mismatch between how the world works and how we think about the world.

The good news is that, in the centuries since Hume, scientists have mostly managed to work around this mismatch as they've continued to discover new cause-and-effect relationships at a blistering pace. This success is largely a tribute to the power of statistical correlation, which has allowed researchers to pirouette around the problem of causation. Though scientists constantly remind themselves that mere correlation is not causation, if a correlation is clear and consistent, then they typically assume a cause has been found – that there really is some invisible association between the measurements.

But here's the bad news: the reliance on correlations has entered an age of diminishing returns. At least two major factors contribute to this trend. First, all of the easy causes have been found, which means that scientists are now forced to search for ever-subtler correlations, mining that mountain of facts for the tiniest of associations. Is that a new cause? Or just a statistical mistake? The line is getting finer; science is getting harder. Second – and this is the biggie – searching for correlations is a terrible way of dealing with the primary subject of much modern research: those complex networks at the centre of life.

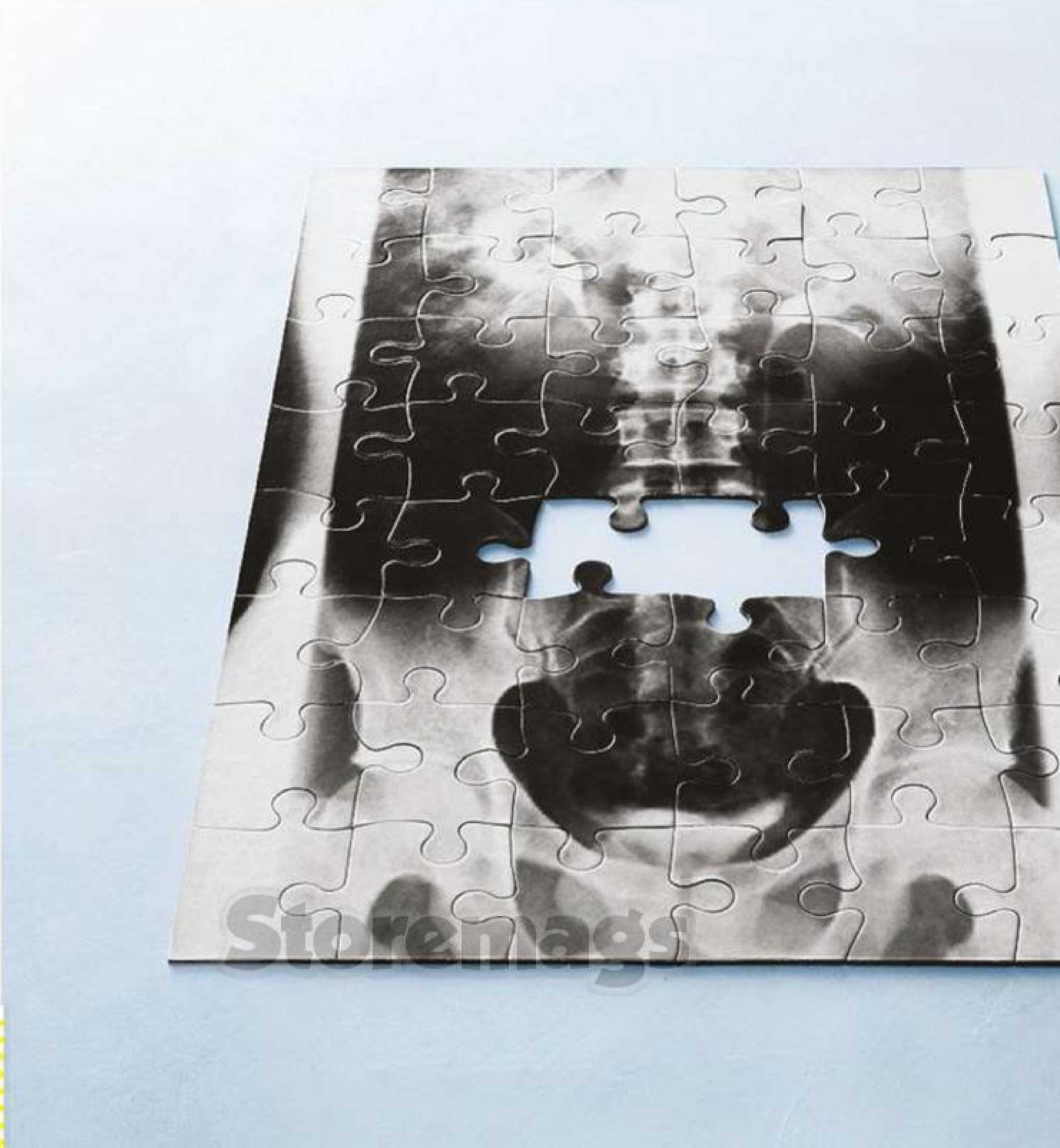
While correlations help us track the relationship between independent measurements, such as the link between smoking and cancer, they are much less effective at making sense of systems in which the variables cannot be isolated. Such situations require that we understand every interaction before we can reliably understand any of them. Given the byzantine nature of biology, this can often be a daunting hurdle, requiring that researchers map not only the complete cholesterol pathway but also the ways in which it is plugged into other pathways. Unfortunately, we shrug off this dizzying intricacy, searching instead for the simplest of correlations. It's the cognitive equivalent of bringing a knife to a gunfight.

These troubling trends play out most vividly in the drug industry. Although modern pharmaceuticals are supposed to represent the practical payoff of basic research, the R&D to discover a promising new compound now costs about 100 times more (inflation-adjusted) than it did in 1950. It also takes nearly three times as long. This trend shows no sign of letting up: industry forecasts suggest that once failures are taken into account, the average cost per approved molecule will top $3.8 billion by 2015. What's worse, even these "successful" compounds don't seem to be worth the investment. We are witnessing Moore's law in reverse.

This returns us to cholesterol, a compound whose scientific history reflects our tortured relationship with causes. At first, cholesterol was entirely bad; the correlations linked high levels of the substance with plaque. Years later, we realised that there were multiple kinds and that only LDL was bad. Then it became clear that HDL was more important than LDL, at least according to correlational studies and animal models. And now we don't really know what matters, since raising HDL levels with torcetrapib doesn't seem to help. Although we've mapped every known part of the chemical pathway, the causes that matter are still nowhere to be found. If this is progress, it's a peculiar kind.

Today, back pain is an epidemic. There's an 80 per cent chance that, at some point in your life, you'll suffer from it. There are so many moving parts in the back that doctors have always had difficulty figuring out what, exactly, was causing a person's pain. As a result, patients were typically sent home with a prescription for bed rest. This treatment was very effective. Even when nothing was done to the lower back, about 90 per cent of people with back pain got better within six weeks. The body healed itself, the inflammation subsided, the nerve relaxed.

For years, this hands-off approach remained the standard medical treatment. That all changed, however, with the introduction of magnetic-resonance imaging in the



late 70s. These diagnostic machines use powerful magnets to generate stunningly detailed images of the body's interior. Within a few years, the MRI machine became a crucial diagnostic tool. The view afforded by MRI led to a new causal story: back pain was the result of abnormalities in the spinal discs, those supple buffers between the vertebrae. The MRIs certainly supplied bleak evidence: back pain was strongly correlated with seriously degenerated discs, which were in turn thought to cause inflammation of the local nerves. Consequently, doctors began administering epidurals to lessen the pain, and if it persisted they would surgically remove the damaged disc tissue.

> The failure of this drug in particular has not ended the development of new cholesterol medications. **THE POTENTIAL MARKET FOR THEM IS SIMPLY TOO HUGE**

But the vivid images were misleading. It turns out that disc abnormalities are typically not the cause of chronic back pain. The presence of such abnormalities is just as likely to be correlated with the absence of back problems, as a 1994 study published in *The New England Journal of Medicine* showed. The researchers imaged the spinal regions of 98 people with no back pain. Two-thirds of normal patients exhibited "serious problems" such as bulging or protruding tissue. In 38 per cent of these patients, the MRI revealed multiple damaged discs. But none of these people was in pain. The study concluded that, in most cases, "the discovery of a bulge or protrusion on an MRI scan in a patient with low back pain may frequently be coincidental".

This is not the way things are supposed to work. We assume that more information will make it easier to find the cause, that seeing the soft tissue of the back will reveal the source of the pain, or at least some useful correlations. Unfortunately, that often doesn't happen. Our habits of visual conclusion-jumping take over. All those extra details end up confusing us; the more we know, the less we seem to understand. The only solution for this mental flaw is to ignore a wealth of facts, even when the facts seem relevant. This is what's happening with the treatment of back pain: doctors are now encouraged not to order MRIs when making diagnoses.

The failure of torectrapib has not ended the development of new cholesterol medications – the potential market is simply too huge. Although the compound is a sobering reminder that our causal beliefs are defined by their oversimplifications, that even the best-understood systems are still full of surprises, scientists continue to search for the magic pill that will make cardiovascular disease disappear. Ironically, the latest hyped treatment, a drug developed by Merck called anacetrapib, inhibits the exact same protein as did torcetrapib. The initial results of the clinical trial, made public in November 2010, look promising. Unlike its chemical cousin, this compound doesn't appear to raise systolic blood pressure or cause heart attacks. (A larger clinical trial is under way to see whether the drug saves lives.) Nobody can conclusively explain why these two closely related compounds trigger such different outcomes or why, according to a 2010 analysis, high HDL levels might actually be dangerous for some people. We know so much about the cholesterol pathway, but we never seem to know what matters.

Chronic back pain also remains a mystery. Doctors have long assumed that there's a valid correlation between pain and physical artefacts – a herniated disc, a sheared muscle, a pinched nerve – yet there's a growing body of evidence suggesting the role of seemingly unrelated factors. A recent study published in the journal *Spine* concluded that minor physical trauma had virtually no relationship with disabling pain. Instead, the researchers found that a small subset of "nonspinal factors", such as depression and smoking, were most closely associated with episodes of pain. We keep trying to fix the back, but perhaps the back isn't what needs fixing. Perhaps we're searching for causes in the wrong place.

The same confusion afflicts so many of our most advanced causal stories. Hormone-replacement therapy was supposed to reduce the risk of heart attack in postmenopausal women – oestrogen prevents inflammation in blood vessels – but a series of recent clinical trials found that it did the opposite, at least among older women. (Oestrogen therapy was also supposed to ward off Alzheimer's, but that doesn't seem to work, either.) We were told that vitamin D supplements prevented bone loss in people with multiple sclerosis and that vitamin E supplements reduced cardiovascular disease. Neither turns out to be true.

Given the increasing difficulty of identifying and treating the causes of illness, it's not surprising that some companies have responded by abandoning research. Most recently, two giant firms, AstraZeneca and GlaxoSmithKline, announced that they were scaling back research into the brain. The organ is too complicated, too full of networks we don't comprehend. We live in a world in which everything is knotted together, an impregnable tangle of causes and effects. Even when a system is dissected into its basic parts, those parts are still influenced by a whirligig of forces we can't understand or haven't considered or don't think matter.

This doesn't mean that nothing can be known or that every causal story is problematic. Some explanations work better than others, which is why, thanks largely to improvements in public health, the average lifespan in the developed world continues to increase. Although our reliance on statistical correlations has strict constraints – which limit modern research – those correlations have managed to identify many essential risk factors, such as smoking and poor diet.

And yet, we must never forget that our causal beliefs are defined by their limitations. For too long, we've pretended that the old problem of causality can be cured by our shiny new knowledge. If only we devote more resources to research or dissect the system at a more fundamental level or search for ever more subtle correlations, we can discover how it all works. But a cause is not a fact, and it never will be; the things we can see will always be bracketed by what we cannot. And this is why, even when we know everything about everything, we'll still be telling stories about why it happened. It's mystery all the way down. W

Jonah Lehrer is the author of Imagine: How Creativity Works *(HMH), out in March*

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VOGUE
MID-SEASON SPECIAL
45 favourite pieces
TILDA SWINTON THE GREAT PERFORMER
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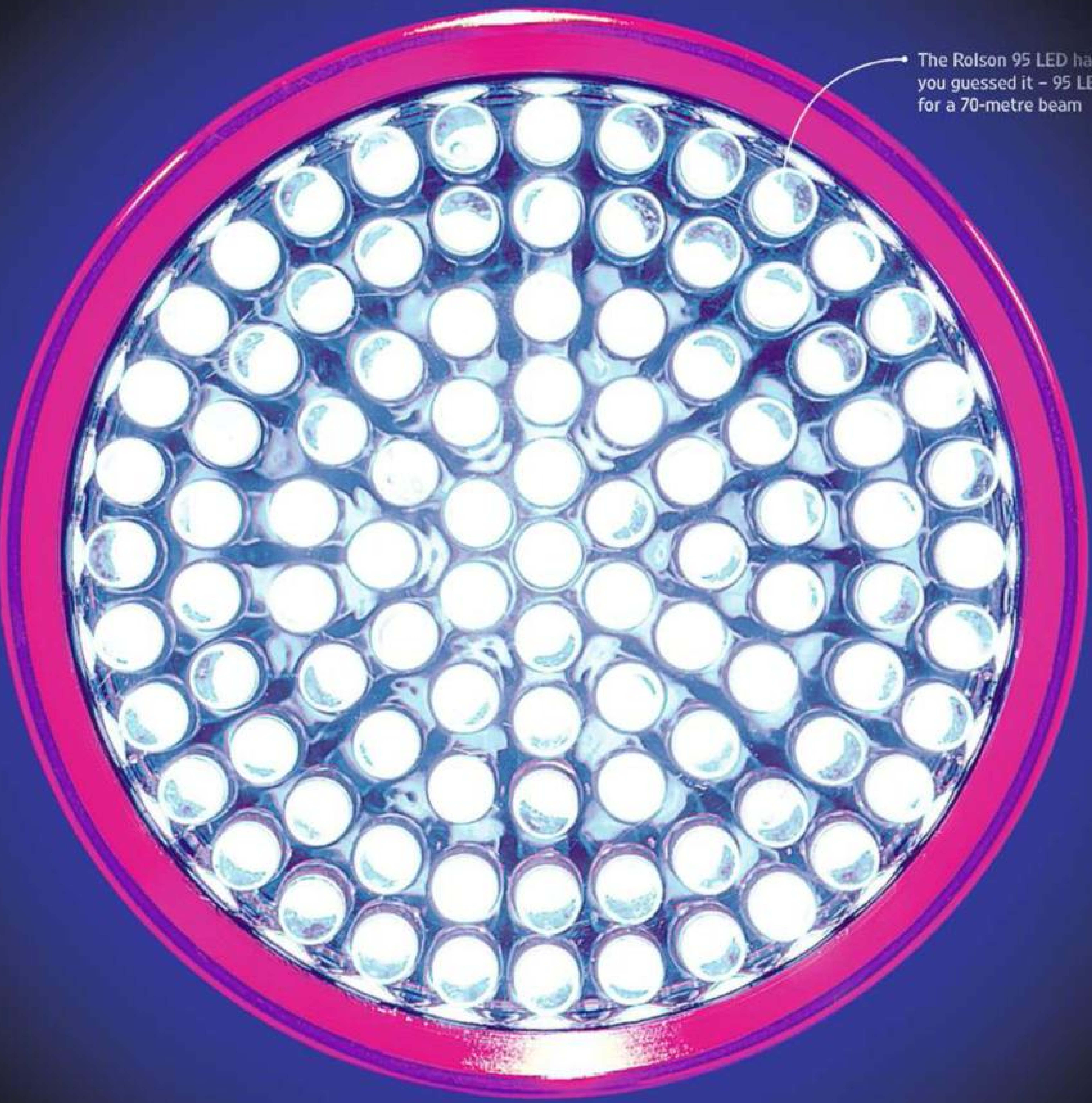
TEST

LAB RESULTS
THIS MONTH: 02.12
- HEADPHONES
- TORCHES
- ELECTRIC GRILLS

EDITED BY
JIM HILL



The Rolson 95 LED has – you guessed it – 95 LEDs for a 70-metre beam

PHOTOGRAPHY: WILSON HENNESSY

Flash-lights

WIRED illuminates the data on the latest tough torches – p130

Want to share your mix? The ear cups have output ports others can jack in to

Stylish sounds

High-end, luxury 'phones that are made to turn heads

MONSTER BEATS PRO

The Dr Dre name underscores these headphones' proficiency with bass-intensive music, notably drum 'n' bass, hip-hop and R&B. The real benefit of these cans, however, is their suitability for other genres. Folk, classic rock and some choice Ingrid Michaelson numbers all sounded superb, with shimmering highs complementing the powerful bass and punchy mids. The heavy design and tight fit may prevent sound leaking out or in, but they make for rather fatigued ears.

WIRED Versatile, high-end audio

TIRED Earache after an hour

●●●●●●●●○○

£350 beatsbydre.com

GROUP ASSESSMENT: PEAK VOLUMES

● Monster 101dB
● Sony 99dB
● Marley 98dB
● Quincy 98dB
● B&W 97dB

MARLEY TTR DESTINY

These are battery-powered, noise-cancelling headphones rocking the Bob Marley name, so it'd be a pity if they didn't do justice to the reggae legend's music. "I Shot The Sheriff" highlighted the deep bass response and the rich overall sound quality. At times that deep bass can become a little overpowering, particularly during heavy rock and metal, but clarity is very good on the whole. The modern design is also extremely comfortable, making these suitable for lengthy listening sessions.

WIRED Most comfortable in test
TIRED Too much bass on occasion
●●●●●●○○○○
£250 thehouseofmarley.co.uk

AKG Q460 QUINCY JONES

At more than £100 less than the Bowers & Wilkins, AKG's Q460 cans deliver a deeper, warmer bass. Yet they don't deliver the same clarity and instrumental separation. Bass and mid-range are emphasised over high frequencies, so vocals are more prominently reproduced. Although a few other instruments didn't come through as clearly, it still delivers a powerful sound from a lightweight design. Despite coming joint last in our round-up, we still felt the Q460s performed adequately.

WIRED Lightweight but sturdy
TIRED Lacks some versatility
●●●●●○○○○○
£130 uk.akg.com

SONY PIIQ MDR-PQ1

These eye-catching headphones are aimed as much at the image-conscious as the music lover, and feature an unusual Velcro fastening for adjusting headband size. Sound quality is balanced, with no special emphasis on bass or treble, but leaves neither end of the spectrum lacking. Electronic music sounded just as good as rock and folk, with punchy mids and well-defined vocals. Audio was the least clear overall, but these headphones are decent value for money.

WIRED Good looking; comfortable
TIRED Far from pro-level audio
●●●●●○○○○○
£80 sony.co.uk

TEST

BOWERS & WILKINS P5

The premium price is justified by the exceptional comfort and superb performance of B&W's cans. They shone with classical, acoustic, pop and rock. Paloma Faith proved a winning choice to demonstrate the P5's deliverance of rich sonic detail, a wide-open soundstage and some truly breathtaking vocals. Sparkling cymbals and strings were also beautifully reproduced, making for some luscious listening. However, balanced output means deep bass gets less love than others on test.

WIRED Clear, rich sound
TIRED Not for lovers of bass
●●●●●●●●○○
£250 bowers-wilkins.co.uk

HOW WE RATE

1> A complete failure in every way
2> Barely functional – don't buy it
3> Serious flaws – buy with caution
4> Downsides outweigh upsides
5> Recommended with reservations
6> A solid product with some issues
7> Very good, but not quite great
8> Excellent with only a few niggles
9> Nearly flawless – buy it now
10> Metaphysical product perfection

HOW WE TESTED

Wired.co.uk's editor, Nate Lanxon, measured the output of each product using an SPL meter, as well as listening closely to audio output to determine sound quality. For the assessment he used a wide range of music, from Fleetwood Mac to Slayer, copied from CDs into 16-bit, 44.1kHz uncompressed digital files. These lossless files were decoded by a Beresford TC-7520 digital-to-analogue converter and amplified by a Denon CX3 amp into each pair of headphones through their supplied cabling.

LISTENING LEVELS

	BEATS PRO	MARLEY TTR DESTINY	AKG Q460	SONY PIIQ MDR-PQ1	BOWERS & WILKINS P5
Type	Over ear	Over ear	On ear	Over ear	On ear
Weight	430g	430g	120g	255g	195g
Minimum frequency response	20Hz	20Hz	11Hz	8Hz	10Hz
Maximum frequency response	20kHz	20kHz	29.5kHz	25kHz	25kHz

PHOTOGRAPHY: WILSON HENNESSY; DAVE LIDWELL. WORDS: NATE LANXON

PRINCETON TEC AMP 3.5

The plastic and rubber body of the AMP 3.5 makes it resilient enough to cope with rough conditions, and the Day-Glo body means it is easy to spot in a rucksack. Our tester found the controls – click to turn on, click to dim, hold to turn off – tedious. Changing batteries also proved tricky. However, the torch is compact and sturdy, and sits nicely in the hand. Another advantage is its comparatively low weight of 122g. Lack of focus mechanism means you're stuck with a wide beam, but with a range of 75 metres, it packs a lot of punch for its size.

WIRED Semi-ruggedised body
TIRED Fiddly operation
●●●●●●●○○○
£21.99 princetontec.com

LED LENSER P7

The gunmetal feel of the P7 is no coincidence; this compact flashlight is marketed at security services (as well as caving enthusiasts). The aluminium body and rubber button, located on the torch butt, feel durable and well built, and the sliding-head mechanism that focuses the beam is smooth and simple. For a small torch its 200 lumens are vastly powerful. The tester also enjoyed loading the four AAAs into the circular battery housing as if they were some kind of ammunition.

WIRED Brightness; build quality
TIRED An expensive option
●●●●●●●●○○
£54.99 halfords.com

ROLSON 95 LED ALUMINIUM

This multi-LED flashlight does exactly what it claims – it's bright and lightweight. However, the 95 feels tinny, and unscrewing either the butt (to slot in batteries) or the head makes the thin metal scrape unpleasantly. The barrel has a knurled textured to aid grip and the rubber on/off button is straightforward to operate. On the downside, the lack of beam focus means the light is dispersed, and there is no option for spotlighting. Despite its size, the Rolson is outclassed on brightness by the smaller Maglite and Lenser. It also comes in black or silver.

WIRED Lightweight; inexpensive
TIRED Tinny build quality
●●●●●●○○○○
£22.50 www.rolsontools.com

MAGLITE LED 2-CELL D

The Maglite feels solid and well built, and comes with a ten-year warranty. However, at 440g it is a little on the heavy side. With 114 lumens it's not the most powerful on test, but the 298-metre beam is unmatched. With a spot to flood focus, which is operated by twisting the head, this torch is versatile but remains simple to operate. To replace the batteries, just screw off the base and drop them in. Maglite claims it will withstand drops from one metre, but our tester thought it felt rugged enough to handle more.

WIRED Tough, simple and stylish
TIRED Heavy to carry around
●●●●●●●●○○
£40 amazon.co.uk

HOW WE TESTED

Each torch was tested for general usability and ease of battery change. They all survived a drop onto concrete from 75cm (approximate holding height), though some felt sturdier than others during handling. To test for beam distance, we took the torches to an area with no street lights at 8pm GMT and their light beams aimed at a WIRED logo (black on white, A4). The tester and two adjudicators stepped back from the logo until details could no longer be distinguished.

ENLIGHTENING DATA

	PRINCETON	MAGLITE	LENSER	ROLSON	STANLEY
Weight (inc batteries)	122g	440g	190g	118g	655g
Light source	Single LED with reflector	Single LED with reflector	Single LED with reflector	95 LED cluster	Single LED with reflector
Batteries	4 x AAA	2 x D	4 x AAA	3 x D	3 x D
Lumens	100	114	200	NA	85
Beam distance (claimed)	75m	298m	210m	NA	NA
Useful beam distance	80m	390m	240m	70m	320m
Length	143mm	258mm	134mm	292mm	330mm

PHOTOGRAPHY: WILSON HENNESSY; DAVE LIDWELL. WORDS: DAN SMITH

Lighting the way

WIRED puts the spotlight on top-end torches for dark winter nights

STANLEY FATMAX 3D ALUMINIUM

The Stanley FatMax 3D takes design cues from a socket set with large, hexagonal moulding and a sturdy build. Its aluminium body is weighty enough to feel well built, but not unwieldy, and its focusing beam has a wide range. The yellow hi-viz rubber bands at the base and head of the torch are a practical touch, but the in-handle battery compartment rattled when carrying, and it requires three heavy D-type batteries.

WIRED Feels tough and well built

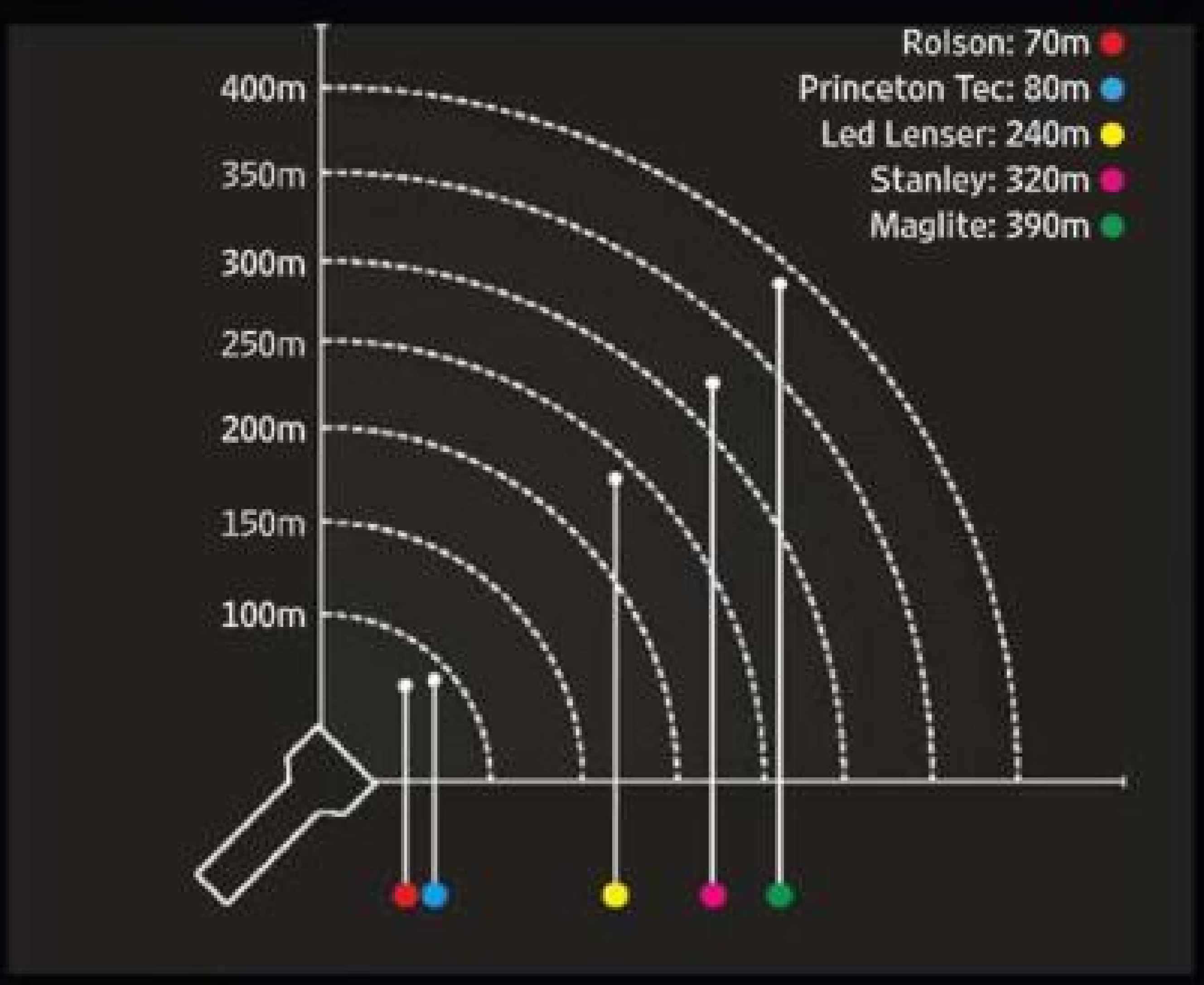
TIRED Large, heavy batteries add bulk

●●●●●●●●○○

£30 stanleytools.co.uk

The Stanley FatMax is made of heavy duty anodised aluminium

THE SHINING: USEFUL BEAM DISTANCES



TO OPEN FLAT
Griddle
150
200
Selector
Griddle
Grill-Pa
Grill-Panini
Low
High
Warm

A relentless grilling

WIRED sears steaks and stats on the latest in electric cookware

CUISINART GR4NU GRIDDLE & GRILL

The grill clips off easily and flips over to a hotplate on this design, which is a combination griddle and grill-panini maker. Professional chef Jon Jones thought it would be perfect for cooking fish, shellfish, asparagus and halloumi. The grill had the shallowest bar marks out of the five machines tested, and was the least effective at draining fat. But this can be an advantage when cooking steak as it helps with caramelisation. "I used the grill-panini setting for the steak, and turned the heat dial up to the sear setting," says Jones. "The heat did not conduct through the meat and the gristle very well. The grill doesn't seem to get as smoking hot as the others. Our steak was only slightly caramelised, and was more fibrous and tougher to eat."

WIRED Recipes included

TIRED Dated design; no temperature-ready indicator

●●●●●●●○○○

£100 lakeland.co.uk

SALTER PRECISE DIGITAL HEALTH GRILL

Smart design features include a digital temperature display, which shows when you go from 150°C to 260°C. It has a sturdy body with a compact lock feature on both sides to hold the grill lid in place, and can handle up to three steaks at one time. "With deep bar marks, the steak cooked very well," says Jones. "The lid was as hot as the base grill, which gave a consistent cook on both sides. It cooked a perfect medium-rare steak."

WIRED Professional equipment

TIRED Small side-draining pot

●●●●●●●●○○

£59.99 salterhousewares.com

SIZZLING STATS

	CUISINART	SALTER	COOKWORKS	TEFAL	GEORGE FOREMAN
Time taken for grill plate to reach max temperature	4 min 30 sec	4 min 20 sec	2 min 51 sec	5 min 45 sec	6 min 4 sec
Removable plates	Yes	No	No	Yes	No
Dishwasher-safe	Yes	No	No	Yes	No
Dimensions of single grill plate (length x width)	28 cm x 22 cm	29 cm x 24 cm	29 cm x 23 cm	36 cm x 22 cm	33 cm x 23 cm

HOW WE TESTED

With the help of professional chef Jon Jones from the Waitrose Cookery School, we cooked five seasoned 300g sirloin steaks for two minutes on each grill to assess their performance. The steaks were similarly seasoned and the grills set to their highest settings, as recommended by our chef, and the crucial taste test was conducted after setting the steaks aside to relax for two minutes. After taking into account the time taken to heat up each grill, time taken to clean it, its ease of use and its value for money, we awarded overall scores out of ten.

COOKWORKS SIGNATURE HEALTH GRILL

This four-to-six-portion grill has a floating hinge to assist with even cooking and also a temperature-ready indicator so that you know when to begin. "It's simple but it works," says Jones. "I used the highest setting [eight] and the grill heated quickly and got very hot." The steak was bar-marked perfectly after two minutes and the top grill heated to the same temperature as underneath so it was evenly cooked.

WIRED Opens flat like a BBQ

TIRED Grill plates are not removable

●●●●●●●●●○

£29.99 argos.co.uk

TEFAL XL HEALTH GRILL COMFORT

The grill plates open up 180° to give you a large, eight-portion cooking surface. Both grill plates and drip tray are removable and dishwasher-safe, but there are nooks that could become fiddly to clean. "There are three settings on this grill and I used the hottest," says Jones. "After two minutes, the steak was not bar-marked on the top and barely marked on the underside. There is no caramelisation and the steak is verging on rare in the centre."

WIRED Flat surface; oven mode

TIRED Bulky design

●●●●●○○○○○

£129.99 tefal.co.uk

GEORGE FOREMAN ENTERTAINING GRILL 14054

The large plate fits four steaks comfortably, but crucially there are no heat settings – just a simple on/off. "This makes it difficult to judge how long the steak needs to cook," says Jones. "Once the steak was cooked it only had bar marks on the underside as the top grill was not nearly as hot as the bottom." The steak was still juicy, though. With no LED indicators, this is the simplest but least flexible grill.

WIRED Easy to wipe clean

TIRED Plastic lid; unsturdy design

●●●●●○○○○○

£79.99 georgeforeman.co.uk

PHOTOGRAPHY: WILSON HENNESSY; DAVE LIDWELL. WORDS: EMILY PECK

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Overheard in the WIRED office, flicking through a rival publication:
"Oh no, look at that photo – he looks like he's been in a horrible accident." "But he might have been in a horrible accident."
"Oh yeah. Sorry."

Our web team chalked up its 52nd podcast (wired.co.uk/podcast) last month – that's a whole year of chart-topping chat. For its anniversary recording Nate Lanxon, Olivia Solon and Duncan Geere discussed wine bottles made from paper, lab-grown hamburgers and Mongolia's plans to cool itself with huge blocks of ice. Listeners: you never know you needed it, but one year down the line, you can't do without it.

Become a fan of our Facebook page (facebook.com/wireduk) and join the community. Recent highlights include:
What word do you love that gets far too little use?
"Wally"
"Pernicketily"
"Hippopotomonstrosesquipedeliaphobia"
"Ostensibly"
"Scrotum"
Please go online for more intelligent debate.

Moustaches. We all have our opinions of them, and a cursory glance at the examples below will surely only strengthen those views. But you can't argue with the £3,068 raised by WIRED's male workforce (*pictured*) by taking part in the annual Movember event. The office never looked so butch, and probably never will again.

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Smart List (p82): illustrations of Juliana Rotich and John Armstrong are based on photographs by Robert Leslie and Kate Burton respectively

Sources for Labnotes (p30): **[1]** Weinberg, B 2009 "A Model of Overconfidence", *IZA Discussion Paper Series* No. 4285 **[2]** Williams, L and DeSteno, D, 2009 "Pride: Adaptive Social Emotion or Seventh Sin?" *Psychological Science,* vol. 20 issue 3, pp284-288 **[3]** Moss-Racusin, C et al, 2010, "When men break the gender rules: Status incongruity and backlash against modest men", *Psychology of Men and Masculinity,* vol. 11 no. 2, pp140-151 **[4]** Wood, JV et al, 2009, "Positive self-statements: power for some, peril for others", *Psychological Science* vol. 20 no.7, pp860-866 **[5]** Huang, L et al, 2010 "Powerful Postures versus Powerful Roles, Which Is the Proximate Correlate of Thought and Behavior?", *Psychological Science,* vol. 22 no. 1, pp95-102.

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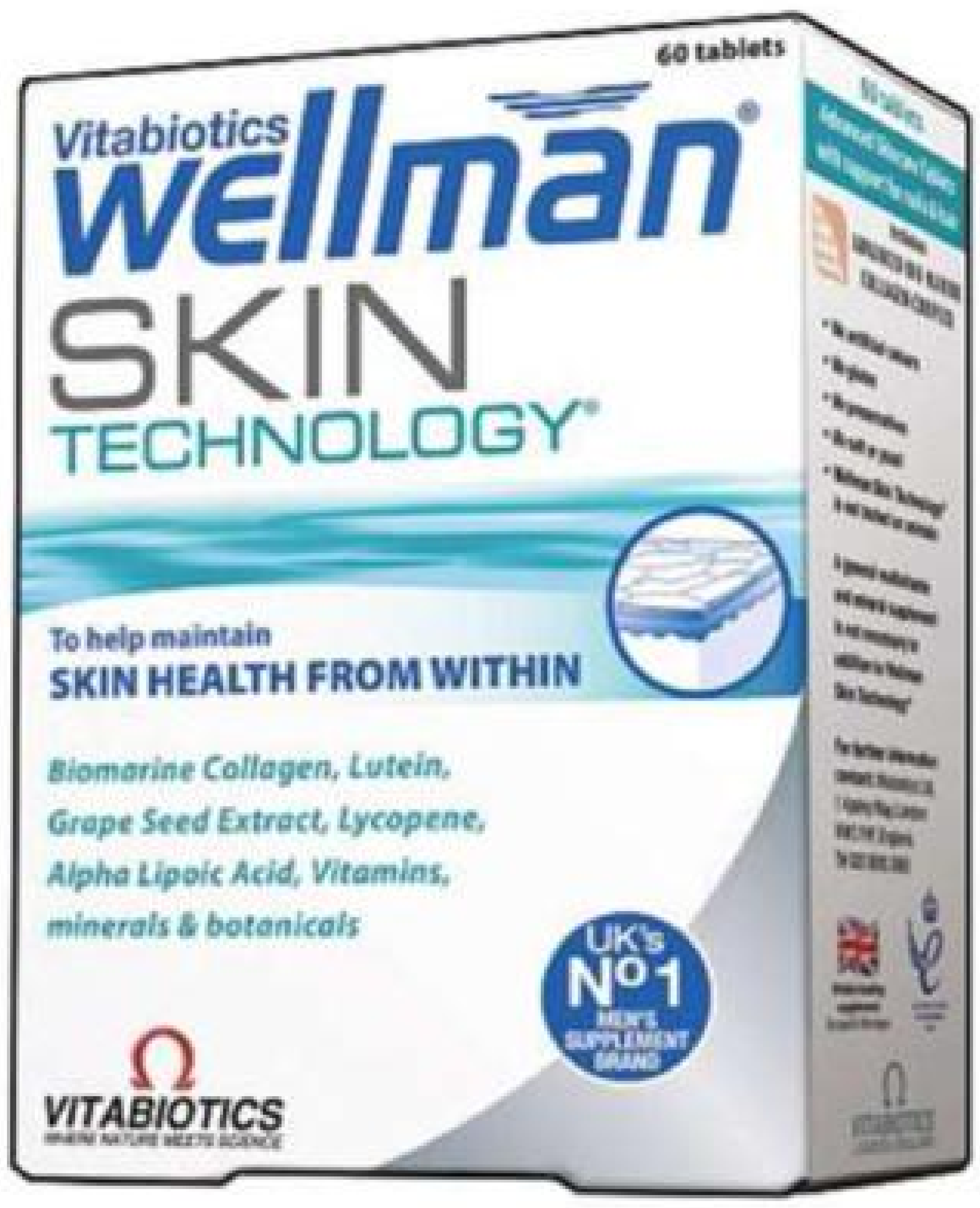
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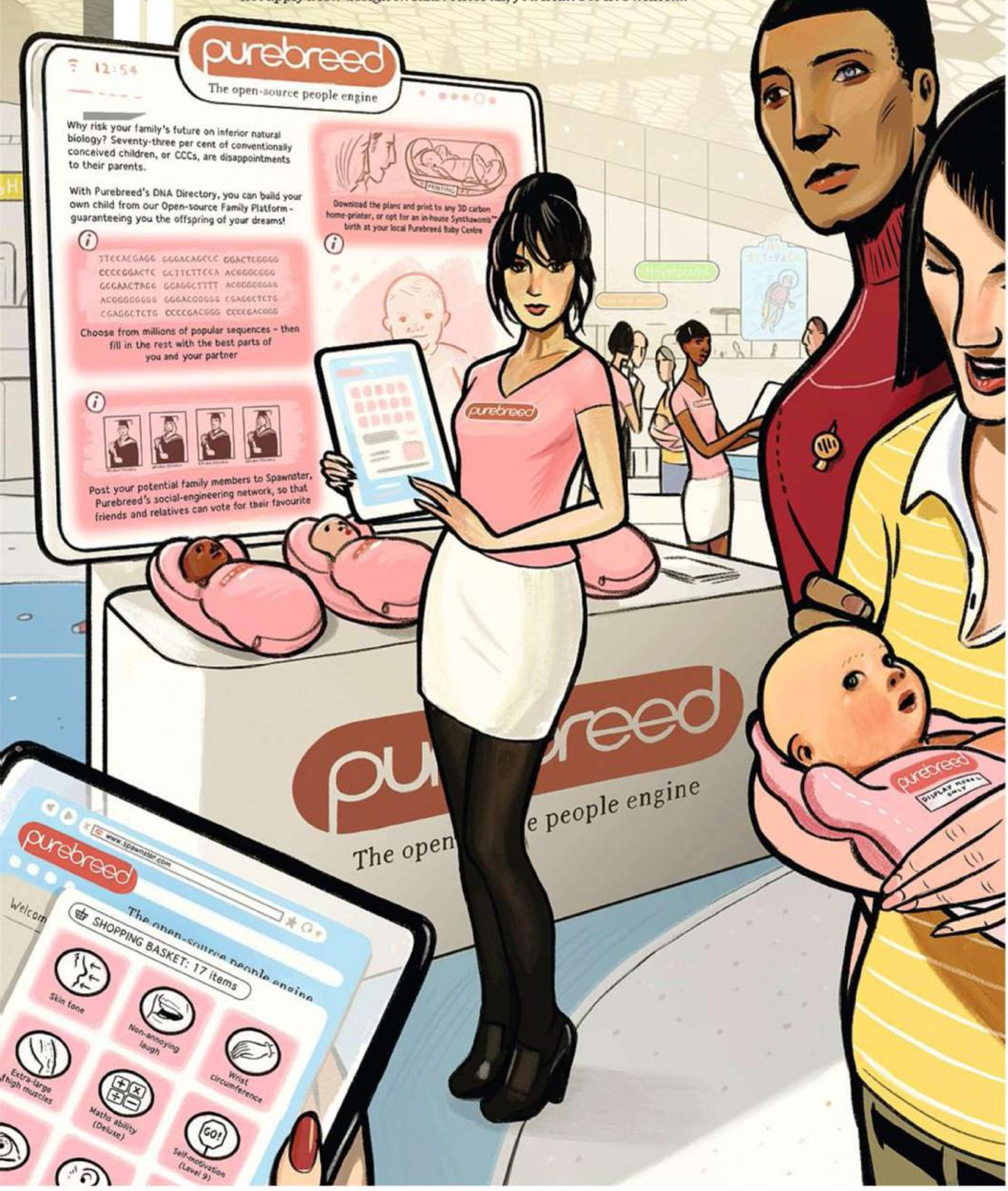
021: PUREBREED Reproductive biology is messy and unpredictable – and creating an unattractive baby could mean social death. Why not apply a few design tweaks? After all, you'll have to live with it…



12:54
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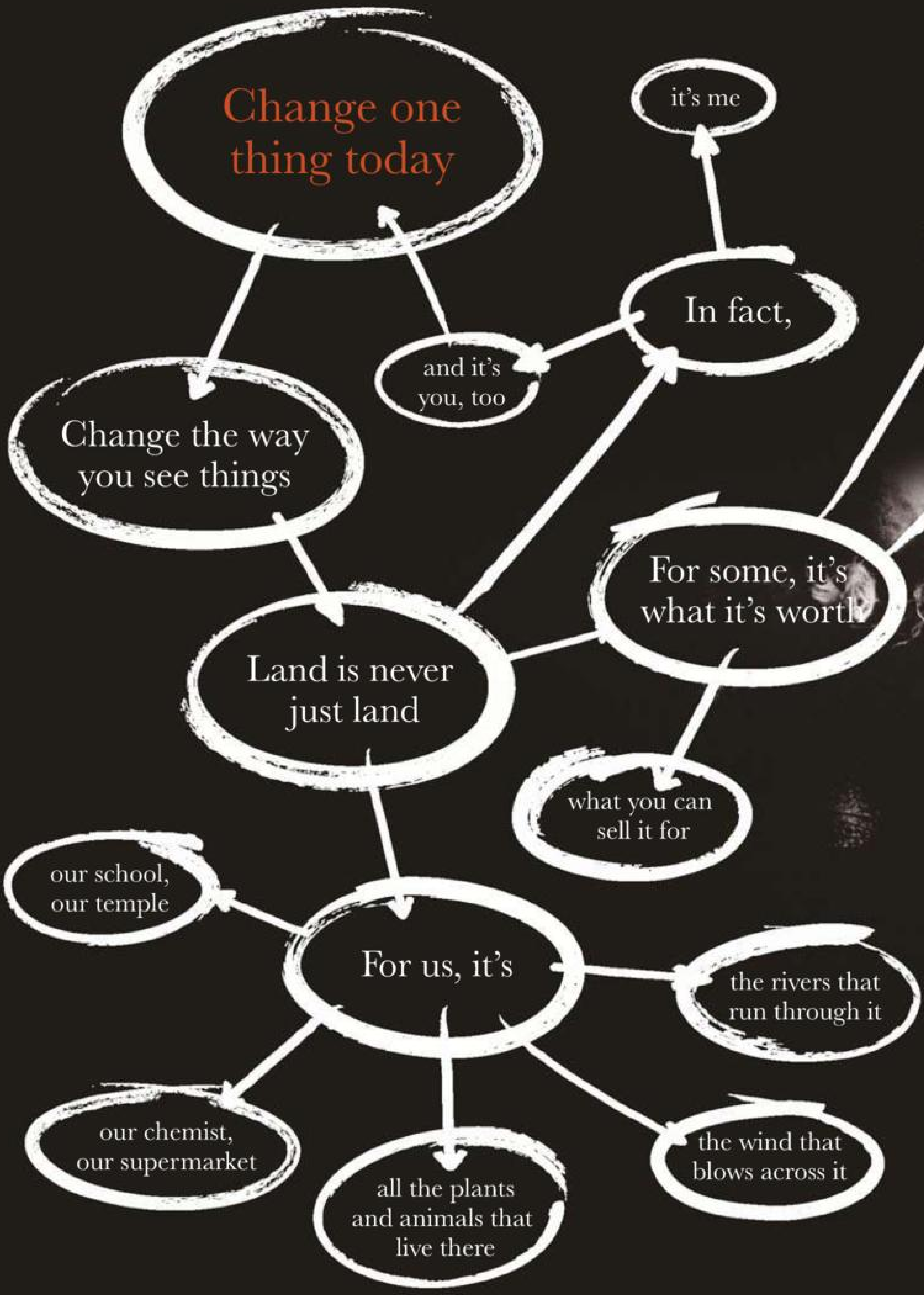

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Change the way you see things

Land is never just land

For us, it's

our school, our temple

the rivers that run through it

the wind that blows across it

all the plants and animals that live there

our chemist, our supermarket

For some, it's what it's worth

what you can sell it for

what you can dig out of it

what you can build on it

In fact,

it's me

and it's you, too

Because if you can change the way you see things, you can change anything.

If you can change the way you see things, you won't just help us to survive. You could help stop species extinction and many other urgent environmental problems the world faces today.

Survival
for tribal peoples

www.survivalinternational.org/changeyourmind

Picture © Claudia Andujar

Samsung GALAXY Note
THE PHONE THAT DOES IT ALL

SAMSUNG

AFTER WORK WHY NOT CATCH A MOVIE?

SUPER HD AMOLED

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